THE ARTIFICIAL INSEMINATION OF CATTLE

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PREFACE

The object of this little book is to assist those who may wish to use artificial insemination for the improvement of cattle. Its use in farm practice is comparatively new in this country and we have much yet to learn concerning the best way to run Societies. It is hoped that this account, which is based largely on experience gained at the Cambridge and District Cattle Breeders' Society's Station, may be of assistance to those who are starting other stations, or practising artificial insemination in their own herds.

While the views given here represent our own opinions we would like to express our thanks to the members of the original Management Committee (Messrs. J. S. Chivers, J. Martin, J. Edwards, A. Walton, W. S. Mansfield, C.B.E., A. Newman, J. A. MacMillan, O.B.E., A. Palmer, J. Inglis, F. T. Day, F.R.C.V.S., L. E. A. Rowson, M.R.C.V.S.) and herd-owning members of the Society, by whose active co-operation all difficulties in the early stages of the formation of the Society were overcome.

We would also express our appreciation of the painstaking care and active interest of the Staff (*Secretaries*: Miss R. Purver, Miss H. Mutimer; *Assistant Secretary*: Mrs. Pitt; *Head Stockman*: Mr. A. Waterfield; *Assistant Stockman*: Miss M. Duncan (W.L.A.); *Inseminators*: Messrs. W. Watson, C. Unwin, J. Willmer) who, in their various capacities, in no small measure contributed to the success of the venture.

A tribute must also be paid to the Agricultural Improvement Council of the Ministry of Agriculture and Fisheries which initiated the setting-up of the Cambridge and Reading Stations in the autumn of 1942 and spring of 1943 respectively, and provided funds for their maintenance during the initial stages and a Supervisory Committee (*Chairman*: Mr. C. Nevile) to guide their development.

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INTRODUCTION

Artificial insemination has been used for many years in this country by veterinarians for the cure of certain forms of sterility in domesticated animals, but it was not until improved methods of collecting and storing semen were discovered shortly after the end of the 1914-19 war that it became practicable to use artificial insemination in ordinary breeding operations.

The main advantage of artificial insemination in this country is that it enables the small breeder of dairy cattle, having only a few cows, to obtain the use of a good bull for his herd so that the heifers which he rears and which come into his herd will be an improvement on their dams.

Few people, perhaps, realise what a high proportion of our dairy cows are kept in small herds. The following table shows the distribution of cows by herd size in the county of Cambridge.

SIZE OF DAIRY HERDS IN THE COUNTY OF CAMBRIDGE

Size of Herd (Cows)	No. of Herds	Total No. of Cows*	Cows as per cent. of total	No. of herds with bull	No. of herds without bull
1–5	1409	3281	22·75	85	1324
6–10	353	2647	18·25	104	249
11–15	168	2248	15·50	114	54
16–20	87	1500	10·75	77	10
21–25	51	1141	8·00	45	6
26–30	31	860	6·00	31	—
31–35	24	782	5·50	22	2
36–40	9	345	2·50	9	—
41 and over	28	1553	10·75	28	—
Total	2160	14417	100·00	515	1645

* These figures do not include in-calf heifers.

This shows that over half of the dairy cows in this county are in herds of 15 cows or less. This state of affairs holds to a greater or lesser degree for other areas of the country too. For example, Fig. 1 shows in another form the distribution of cows according to herd size in the county of Glamorgan.

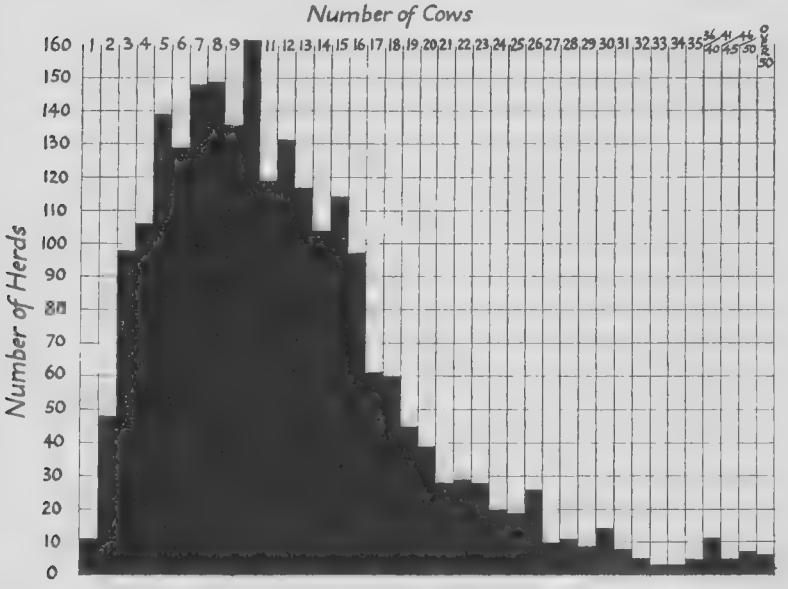


FIG. 1.

If all food had to be purchased at present prices, it would probably cost £50 to keep even a very ordinary bull to-day, and where the herd only consists of 10 cows this would mean £5 per cow got in-calf. On small farms even where the produce is home-grown it will be more economical to have cows artificially inseminated at 25s. per cow and, in place of the bull, keep another cow. The profits from keeping another cow will more than pay all the fees for insemination in the herd. As will be seen from the table many small cow-keepers use other farmers' bulls or try to lower the costs of keeping a bull by taking neighbouring farmers' cows for a service fee, but this in the long run is often more, and not less, expensive, for sooner or later contagious diseases causing abortion and sterility are liable to be contracted. These diseases, such as Trichomonas infection (which causes early abortion and sterility) and contagious abortion, are prevalent in some areas, and artificial

insemination combined with veterinary treatment forms a means of keeping them under control.

Quite apart from the cost of keeping a bull, the cost of buying a high class dairy bull to-day for use in a small herd is prohibitive, and this probably explains why the small farmer does not keep a better bull, and why, in consequence, the general level of our dairy cattle is so poor, for over half of our dairy heifers are bred in these small herds.

Experience of artificial insemination in U.S.S.R., Denmark, and in U.S.A., shows that the progeny are as strong and healthy as those produced from normal matings. There are no scientific grounds to imagine that they would be otherwise. A comparable method (artificial pollination) has produced our improved varieties of crops. Three generations of Dexter cattle have been obtained by artificial insemination at the Animal Research Station, Cambridge, without any noticeable change in the vigour and fertility of the herd.

The progress made in artificial insemination in some other countries in recent years has been striking. For example, in U.S.A. on 1st January, 1945, there were 185 associations owning 650 bulls and providing breeding service for 42,020 herds consisting of 342,012 cows. In Denmark too, while in 1939 there were only 45 associations inseminating 72,000 cows, in 1945 the number had increased to 96 associations using more than 600 bulls and inseminating over 400,000 cows, or about one-third of the cows in the country.

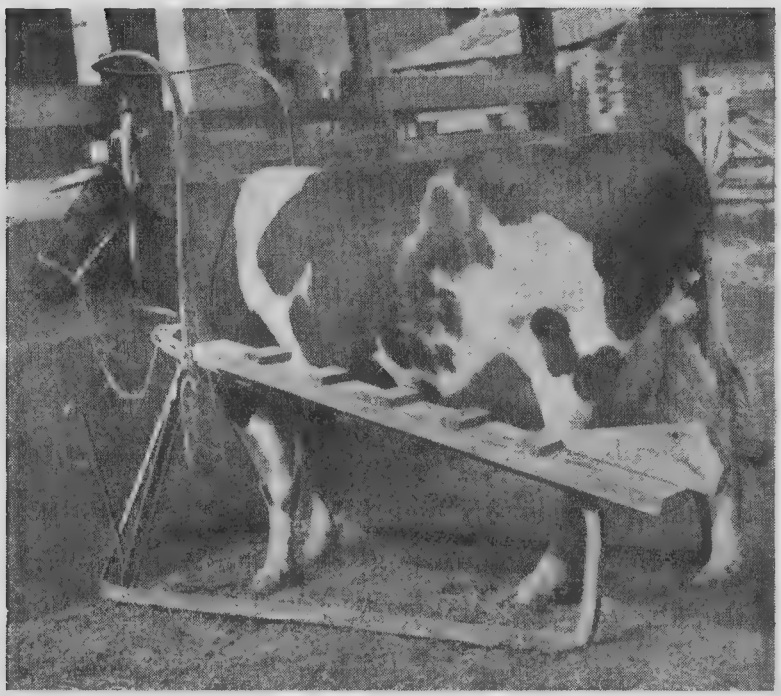
TECHNICAL METHODS

Collection of semen. The semen is collected from the bull by getting him to serve into an artificial vagina which is placed on his penis as he mounts the cow. For this purpose a service crate* is required into which a quiet cow is put (Fig. 2). The rough dimensions of such a crate are shown in the accompanying plan.

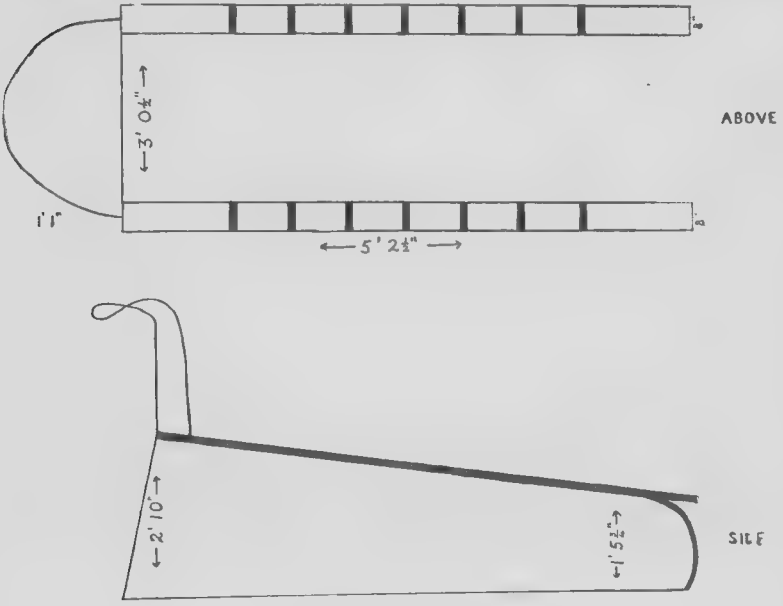
It is not necessary that the cow should be on heat at the time, any cow will do provided she is quiet, of substantial size and free from disease. A sterile cow from a T.T., abortion and Trichomonas free herd in the area would be suitable. It is useful also to have as a reserve a dummy cow (Fig. 3) which can be used if for any reason the collecting cow is incapacitated, or as a change for the bulls.

The service crate and dummy cow are best held in place by being bolted to cement blocks in the floor, by which means they are held firmly during use and can, if required, be moved to another place. This may be necessary in the case of a bull which is getting slow at service and for whom a temporary change of situation may sometimes be desirable. The floor around and behind the service crate and dummy cow should be made of chalk rubble or some non-skid substance so that bulls do not slip when they come for service. The service crate and dummy should preferably be under cover so that there is no danger that water, which will rapidly destroy the sperm, will get into the artificial vagina on rainy days. For the same reason it is desirable to have the way from the laboratory, where the artificial vagina is prepared, to the service crate also under cover. If possible the service crate should be placed in full view of all the bull pens, for this ensures that the bulls can see others mount and hence are kept active and "on their toes." This is especially necessary in the case of bulls that may be slow at service. The collecting cow should normally be kept in a closed box out of sight of the bulls.

*A service crate for this purpose is made by Messrs. King, Hitchin, Herts.

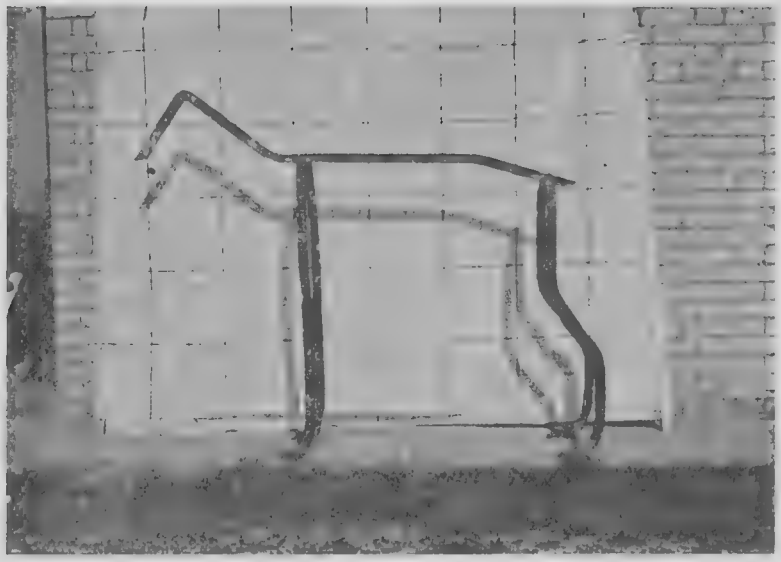


(*a*) Cow in service crate.



(*b*) Plan of crate.

FIG. 2. Service crate.



(*a*) The iron framework.

(*b*) The completed dummy.

FIG. 3. Dummy cow.

The artificial vagina* (Fig. 4) consists of a stiff rubber cylinder (A) about 14 in. long, inside which is fitted a thin, flexible ruber tube (B) (like the inner tube of a cycle tyre); this is doubled over the ends of the cylinder and secured with tape or a rubber ring. The cylinder contains a screw stopper (D) through which the space between the cylinder and thin rubber tube is filled with warm water (C) at

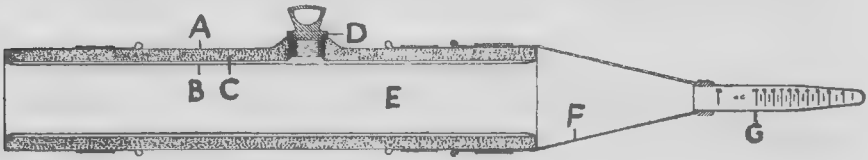


FIG. 4. Diagram of artificial vagina.

A cylinder (A) inside which is fitted a rubber tube (B) folded over the ends, forming a space (C) into which water at body temperature is poured through the hole (D). The inner side of the rubber tube (E) is lubricated with white vaseline. A soft rubber funnel (F) is bound over one end of the cylinder. Into the end of the funnel a graduated glass tube (G) is inserted.

slightly above body temperature. A hot water geyser is suitable for this since it can be brought to the required temperature in a short time. It is very essential that the inside of the artificial vagina should be at the right temperature when the bull serves into it. If it is not the bull may get progressively slower at service, gradually lose interest and eventually refuse to serve into the artificial vagina. A long thermometer placed inside the artificial vagina (E) from the time it is filled until it is used will ensure that it is used only at the correct temperature which should be between 42°–45° C. The amount of warm water put in should be just sufficient to bring the surfaces of the inner rubber tube together. If too much water is put in there will be too much pressure on the penis of the bull when he serves into it, with the result that the ends of the lining may be forced off and some water may contaminate the semen. If there is too little water there will not be enough pressure on the penis to stimulate the bull to ejaculate.

Over one end of the cylinder is now fitted a soft rubber funnel (F), which has a small vent hole to allow exit of air on the thrust of the bull; the funnel is kept in place by a strong rubber band. At the end of the funnel a glass tube (G) is inserted; this is graduated so that the quantity of semen ejaculated into it can be measured immediately after

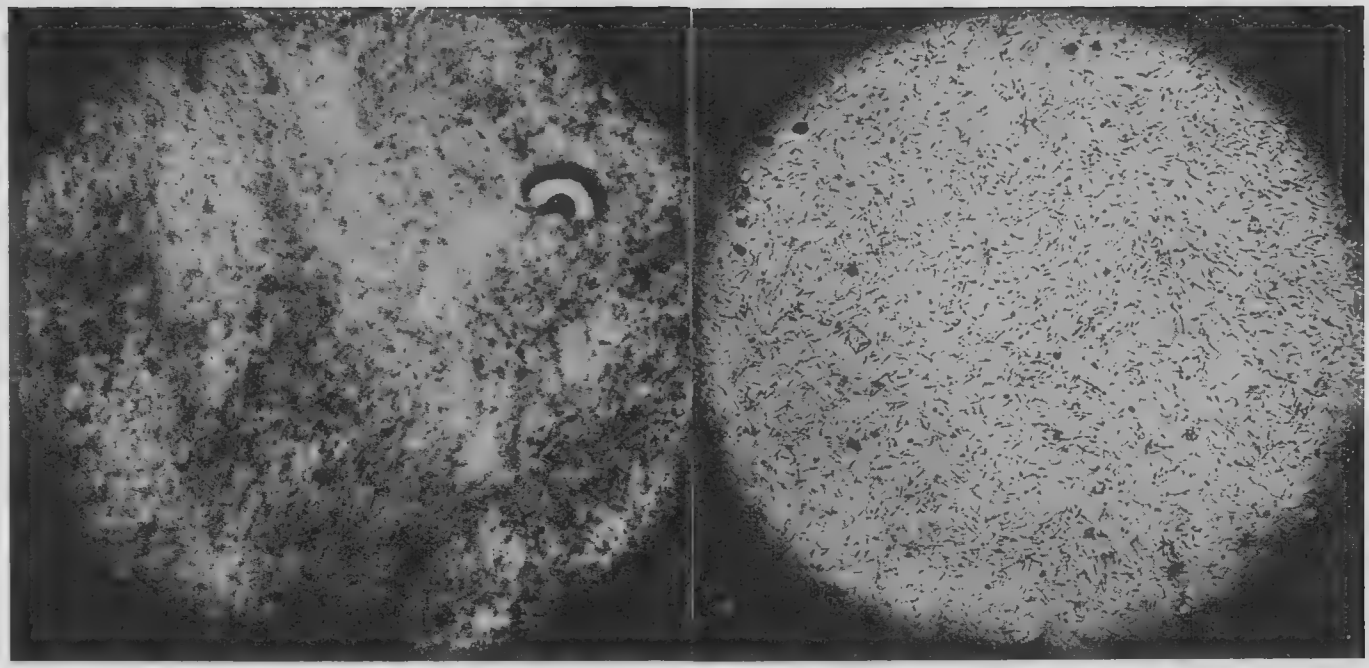
* This apparatus can be obtained from the Holborn Surgical Instrument Co., 26 Ely Place, London.

the service. The tube should be tied in position, otherwise the pressure of the thrust when the bull serves may blow it off.

Just before the artificial vagina is to be used, pure white vaseline is smeared over the inside of the tube (E) with a thick glass rod, so as to lubricate its surface. Care should be taken to spread only a thin coating evenly over the whole surface so that no excess of vaseline runs into the rubber funnel or glass tube.

FIG. 5. Collecting semen from a bull (by a left-handed operator).

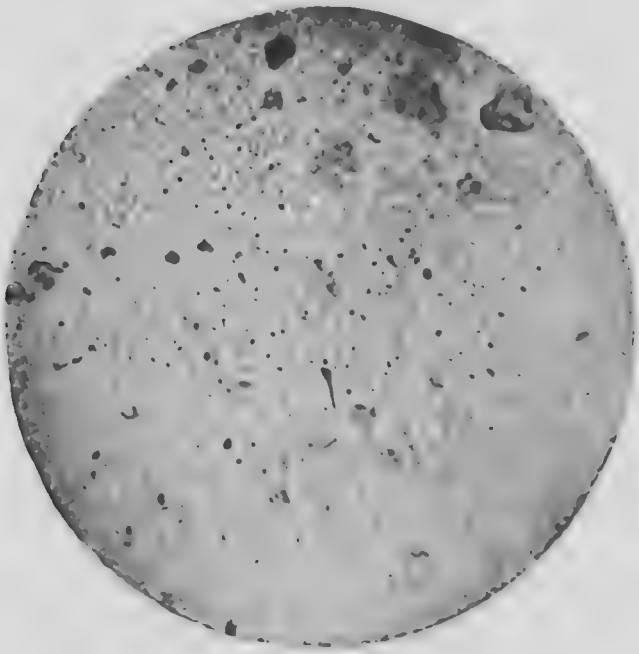
When the bull is led up to the cow in the service crate, the operator (unless he is left-handed), stands on the right of the bull. He holds the artificial vagina in the right hand with the rubber cone and glass tube bent back and caught in the fingers so as to keep the tube warm by contact with the artificial vagina and away from the cow. As the bull mounts, the penis is directed into the vagina by the left hand held under the skin of the sheath, care being taken not to touch the penis itself.



(*a*) Sample of high density, showing wave motion. (*b*) Sample of low density and poor motility.

FIG. 6. Appearance of bull semen under the low power ($\frac{2}{3}$ in.) of the microscope.

(*a*) Moderate sample—low fertility.



(*b*) Poor sample—sterile.

FIG. 7. Appearance of bull semen under the high power (⅛ in.) of the microscope.

As the bull makes his thrust the glass tube is released from the fingers so that the ejaculation takes place directly into the tube and the artificial vagina is then held downwards and shaken so that any semen deposited on the cone will run down into the tube.

Considerable variations will be found in the reactions of different bulls to the artificial vagina, especially after they have been used for some time. It may be found that the animal will thrust the penis into the artificial vagina but refuse to ejaculate. This can be due to various causes such as too high or too low temperature, or pressure, or a combination of these. Some animals will still refuse to serve, however, even when temperature and pressure are correct. If such a bull does thrust into the tube without ejaculating it is quite useless to leave the vagina in position for this is only adding to his dislike for it. If, however, it is removed and the animal frustrated for a second or two by deflecting the penis alongside the teaser cow, and the artificial vagina then quickly dropped into position, he will usually serve vigorously. A little experience will soon show the operator that a modified technique may be necessary for each animal. Most animals, of course, will serve readily into the artificial vagina, but an appreciable percentage require special handling if they are to be kept in constant use, and only experience of the individual bull will reveal what form this handling must take. It is vitally important that all collections, as far as possible, should be carried out by one man, and it is fatal to allow inexperienced persons to practise on the station's bull. If a number of people are allowed to collect it is inevitable that variations, such as the angle at which the vagina is held, will occur, the penis may be damaged and the bull refuse to serve in future. The handling of bulls for collection is probably the most important single factor in the whole process.

Examination of semen. The volume of the ejaculate is read off from the graduations on the tube and the colour of the sample is observed. The amount of semen produced by a mature bull normally varies from about 4 ml. to 8 ml., although it may occasionally amount to 18 ml.. A good sample is opalescent and milky in appearance, while poor samples are clear or slightly turbid. Most samples are white like milk in appearance, but a few bulls produce semen of a rather yellowish tinge, without this necessarily affecting their fertility.

The tube is then removed from the rubber cone and a drop of the semen is taken out by a clean, dry glass rod and placed on a glass slide

and covered with a glass cover-slip. A fairly thick film of semen is required between slide and cover-slip. If too thin the sample will appear less concentrated and less active than it should. Approximately the same thickness of film should be used in each sample examined. The sample can then be examined under a microscope for motility of the sperms. The glass slide should first be warmed to blood heat by holding in the hand (so that it does not get too warm) over a gas burner, otherwise the sperms will not show their full motility. Examined under a $\frac{2}{3}$ in. objective and with a $\times$ 10 eyepiece, a good sample will show rapidly changing waves of concentration in the semen, while poor samples will show only diffused movement (Fig. 6).

Examined under a high power objective ($\frac{1}{6}$ in.) the outlines of the individual sperms can be seen and samples containing few sperms, or many immotile sperms, can be rejected (Fig. 7).

Good, moderate and poor samples of semen can easily be distinguished by these visual methods and with experience a certain degree of accuracy can be obtained so that the veterinarian in charge of the station can decide which samples should be retained for use and to what extent the semen should be diluted.

It is useful, however, to apply from time to time certain more objective tests, of which the most accurate is the estimate of density, or concentration, of the sperms. Estimates of density should provide a continuous record of a bull's production of semen and are a good check on his performance and potential fertility.

Estimate of density by counting. The method employed is similar to that used in the estimation of blood count (Fig. 8). The following procedure has given accurate and reliable results with semen. From a well mixed sample of semen (1) remove exactly 0·1 ml. semen with a precision pipette (2). Wipe the outside of the pipette to remove surplus semen and wash out the contents of the pipette into 9·9 ml. normal saline (4) (0·9% NaCl with trace of formalin or HgI_2 to kill the sperms). This gives a dilution of 1 : 100 (3). From this first dilution further dilutions can be made according to the concentration. If very concentrated a dilution of 1 : 1600 can be made by taking 1 ml. of the first dilution and adding to it 15 ml. of saline. If of average concentration a dilution of 1 : 800 can be made by adding 7 ml. saline to 1 ml. of the first dilution. By experience a dilution can be made which will give a concentration of sperms on the haemocytometer of approximately 5 to 10 cells per small square.

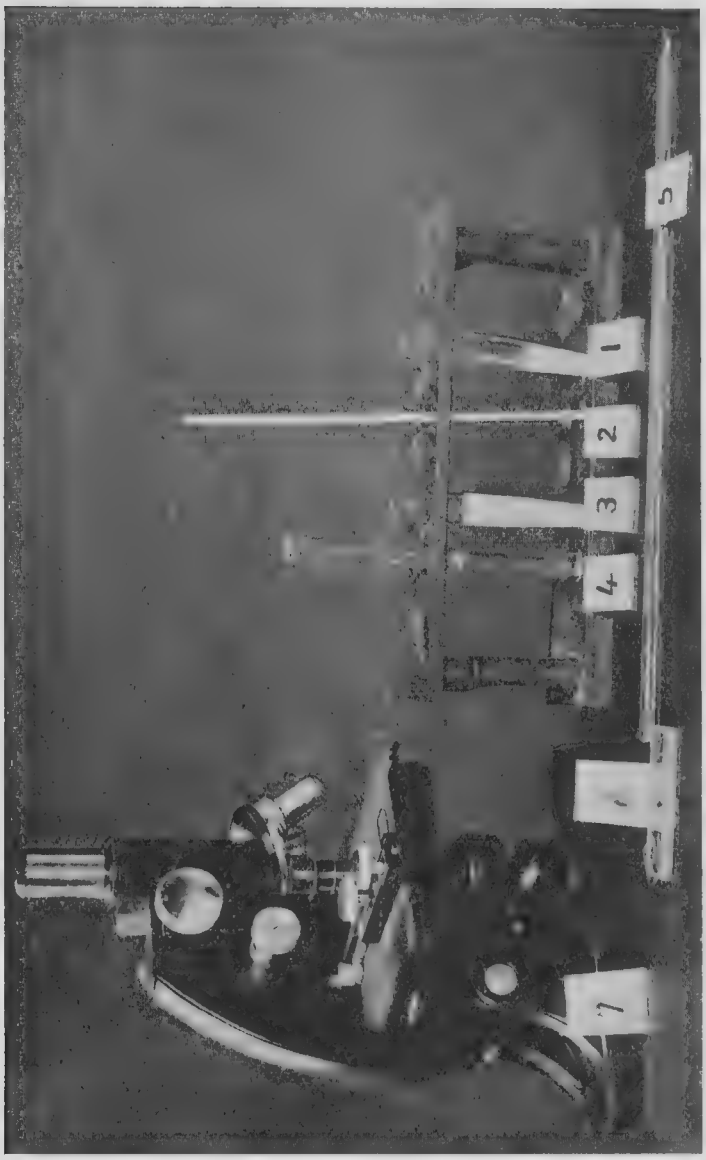


FIG. 8. Apparatus necessary for making a sperm count. (See text for explanation.)

The haemocytometer (6) used should have a depth of 0·2 mm. and Fuchs-Rosenthal ruling. This should be cleaned in alcohol, the coverslip placed in position and a drop of the final dilution of semen run underneath. The prepared slide should now be allowed to stand on the microscope stage (7) for at least ten minutes until the sperms have settled in one focal plane on the bottom of the chamber. On the average about 16 small squares should be counted and at least 100 sperms. This will give an estimate of density accurate to about 10%. Greater accuracy can be obtained by counting a larger number of sperms or by repeating the counts several times and taking an average.

Estimate of density by opacity. A more rapid, but perhaps less accurate estimate of density can be obtained by comparing the opacity of a diluted sample of semen with permanent standard opacity tubes —Brown's tubes* (Fig. 9).

A dilution of 1 part of semen to 29 parts of saline will bring most semen samples within the opacity range of the standard tubes. Comparison should be made by gauging the facility with which small print can be read through the tubes and not by colour comparison. The density of the semen in millions per ml. is given by multiplying the number of the Brown's tube which matches the sample by 5 and by the dilution, i.e. $\times$ 30. For example, if Brown's tube No. 7 gives the nearest match, the density of the sample is $7 \times 5 \times 30 = 1{,}050$ M/ml. This method of estimating density by opacity is not used to any great extent at the Cambridge Insemination Centre.

These estimates of density measure only the number of sperms in a given volume. Broadly speaking, the denser the sample of semen the more active and viable will be the sperms, and therefore the estimate of density may be a fair judge of the quality of the semen. A sample of semen which contains less than 400 millions/ml. will probably produce poor results on insemination even if used fresh and even if a large dose is given. A sample with over 1,000 M/ml. can generally be considerably diluted, stored several days, and can be used in small doses. However, it must be remembered that the estimate of density takes no account of the activity of the sperms. A dense sample of semen may, in fact, contain mostly dead cells and be quite useless for insemination, whereas a less dense sample, especially if from a young bull, may contain very vigorous cells and be much more fertile than the mere estimate of density would indicate. An estimate of density may,

* Brown's standard opacity tubes, obtainable from Messrs. Burroughs, Wellcome, London.

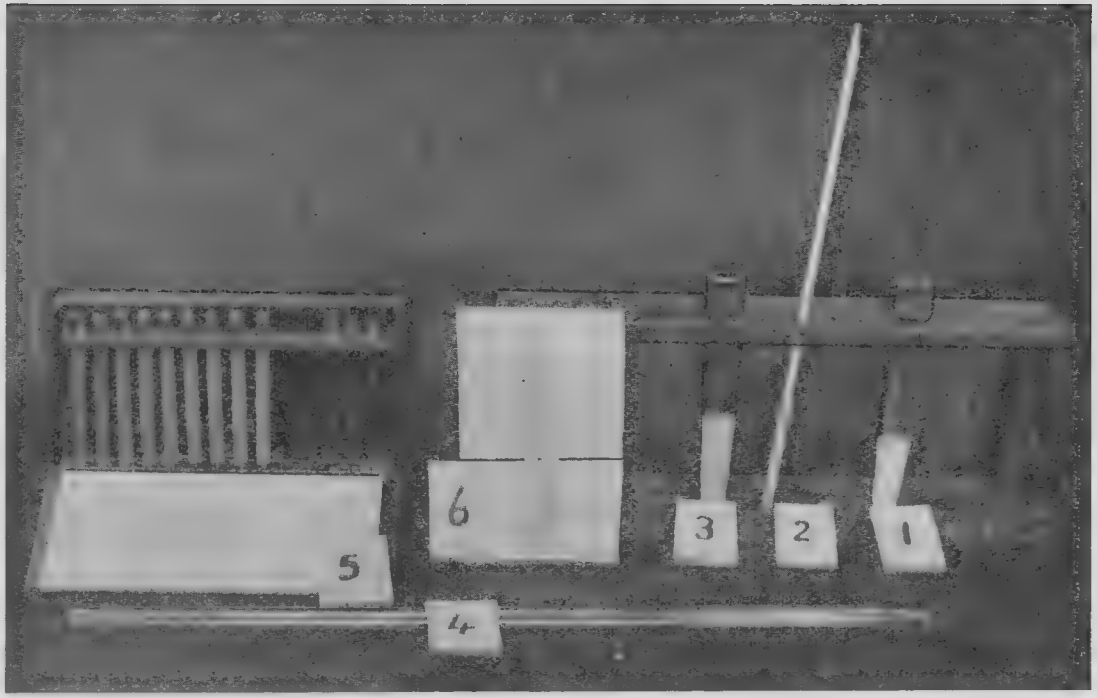


FIG. 9. Standard opacity tubes for estimating sperm numbers in semen.

(1) Semen sample; (2) precision pipette; (3) diluted semen; (4) pipette for filling sample tube; (5) standard opacity tubes; (6) sample tube placed alongside a standard tube: difference in opacity shown in black line running across white card.

therefore, be quite misleading if not combined with the estimate of activity given by the microscopic examination above.

There is at present no sure method, outside the research laboratory, of measuring the activity of the sperms, but some claims have been made recently in the U.S.A. and Denmark for the use of the methylene blue reduction test. The American test is given as follows.

Add 0·8 ml. of egg yolk-citrate to 0·2 ml. semen in a 10 ml. test tube of about 10 mm. diameter; then add to this 0·1 ml. of a methylene blue solution (4·76 gr. crystaline sodium citrate dissolved in 100 ml. distilled water to which is added 50 mg. of methylene blue). Pour on this about $\frac{1}{2}$ in. of liquid paraffin and place the tube in a beaker of water at 45° C., which is placed in a water bath at 47° C. The shorter the time taken for the blue fluid in the tube to return to the yellowish colour of egg yolk the better the sample of semen, that is, the more rapidly the semen will reduce the blue colour, the greater the number and vigour of the sperm in the sample. In a good sample the colour should disappear in $3\frac{1}{2}$ to 6 minutes, while a bad sample, which should be discarded, will require some 9 minutes or more.

It should be noted that this test measures only the total reducing activity of the semen and without a parallel density estimation will not distinguish between a small number of active cells and a large number of relatively inactive cells; nor does it distinguish between the reducing capacity of the sperms alone and that of other reducing substances (e.g. bacteria) which may be present in the semen or yolk. In any case it cannot replace the microscopic examination by eye, since the latter is always used to test both fresh and stored samples, and success in artificial insemination depends much more upon the ability to judge the activity of a stored sample, and to know when to reject it for use, than upon the original activity on the first day of collection.

This test is not used in the normal routine at the Cambridge Insemination Centre.

Samples which contain over 800 million sperm per ml. can be considered good and those under 400 million sperm per ml. poor samples. If the sample of semen is a poor one it is rejected for artificial insemination purposes. By this means it is possible to obtain rather better results in fertility by artificial insemination than from natural mating. For example, in the natural mating of dairy cows in this country, it requires on the average about 1·9 services for each cow got in calf, whereas artificial insemination results on the average give about 1·7 per cow got in calf. Put in another way, with natural matings 50 to 60

cows per hundred stand to the first service, whereas with artificial insemination this figure should be from 60 to 70. Naturally, there is much

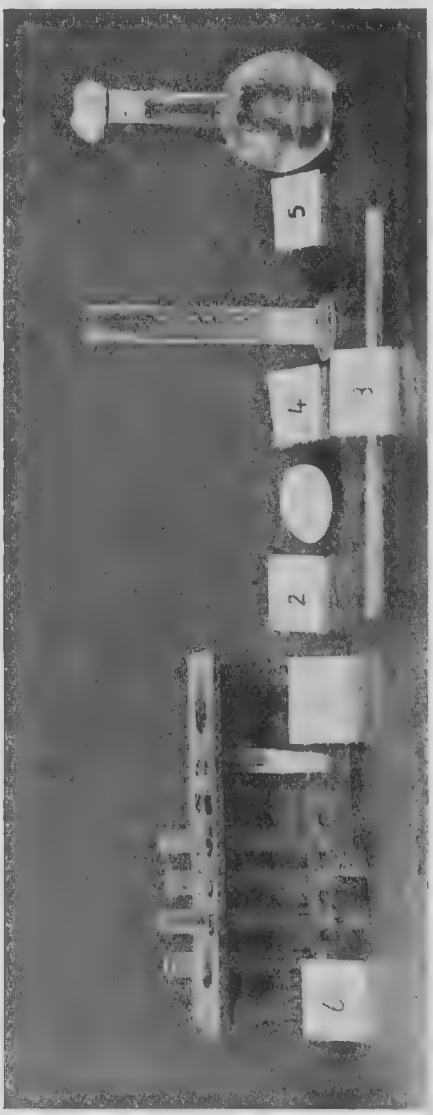


FIG. 10. Materials required for diluting the semen.
(1) Semen sample; (2) egg; (3) glass rod; (4) egg yolk in glass cylinder; (5) buffer solution in flask; (6) tubes in which the diluted semen will be stored.

variation in this respect depending not only on the level of fertility of the bull used, but on the fertility of the cows in different herds (see page 48).

Dilution. If the sample of semen is satisfactory as regards density and motility it is then diluted with egg yolk phosphate (Fig. 10). This not only increases the bulk so that more cows can be inseminated, but also prolongs the life of the sperms in storage and prevents temperature shock to the sperm. The egg yolk phosphate dilutor is prepared as follows.

The buffer solution consists of 2 gm. Na_2HPO_4 (12 H_2O), 0·2 gm. KH_2PO_4, 100 ml. glass distilled water. A quantity of 1 litre is made up at a time, put in 200 ml. flasks, stoppered with cotton wool and autoclaved at 110° C. for 15 minutes. This solution will keep almost indefinitely in the unopened flasks. An opened flask should be kept in the refrigerator.*

To prepare the yolk, fresh eggs, laid within a week of use, from a clean, disease-free flock should be used. The egg should be washed, flamed, and cracked in half, using a flamed scalpel. The white should be carefully poured away, leaving only the unbroken yolk. Any white on the surface of the yolk can be washed off with buffer solution. A slit is now made in the yolk membrane with the flamed scalpel and the yolk poured into a sterile 100-ml. graduated cylinder. Care must be taken to keep back any membrane, since, if present in the dilutor, it tends to clog the inseminating syringes. One or more yolks may be used according to the quantity of dilutor required. An equal volume of buffer solution is now added to the measured volume of yolk in the cylinder, yolk and buffer being thoroughly mixed by stirring and shaking.

The yolk-buffer dilutor may be kept for a few days in the refrigerator, but before use it must be gently warmed to about 20° C.

The extent of the dilution of the semen made will depend on the sample—a good one can be diluted more than a moderate one—and on the number of cows which are likely to be required to be inseminated from it. For moderate samples, or where few cows are likely to be inseminated, 1 : 3 dilution is suitable, while for good samples and several cows 1 : 10 is normally used. With very good samples, and where a lot of cows are required to be inseminated, dilutions of 1 : 16 may be made. Greater dilutions, up to 1 : 50, have been successfully used.

The tubes of diluted sperm are then labelled with the name of the bull, the date of collection (so that they are not used after about the

* Ampoules of sterilised phosphate buffer solution can be obtained from the chemical suppliers, Boots Pure Drug Co., and Burroughs, Wellcome.

FIG. 11. Storage of tubes of semen in the cool chamber. A modern refrigerator.

fourth day—the time when fertility begins to drop off) and the amount of the dilution—thus—K H. 30 Nov. 1/5, which would signify Kingswood Homespun (Friesian) collected on 30th November and diluted 1 part semen to 5 parts yolk-phosphate mixture.

Storage and transport. The tubes of diluted semen are then corked, using ordinary corks, and if not required for immediate use are stored in a cool chamber (Fig. 11) and kept at about 5° C.

Various forms of cool chamber may be used, from an electrically run refrigerator set at the required temperature down to an improvised insulated box which is kept cool by putting in blocks of ice from time to time. Naturally the more constant the temperature control maintained the better will be the results.

When the man making the inseminations sets out on his round he carries with him in his car a strong wooden box which takes all his equipment (Fig. 12).

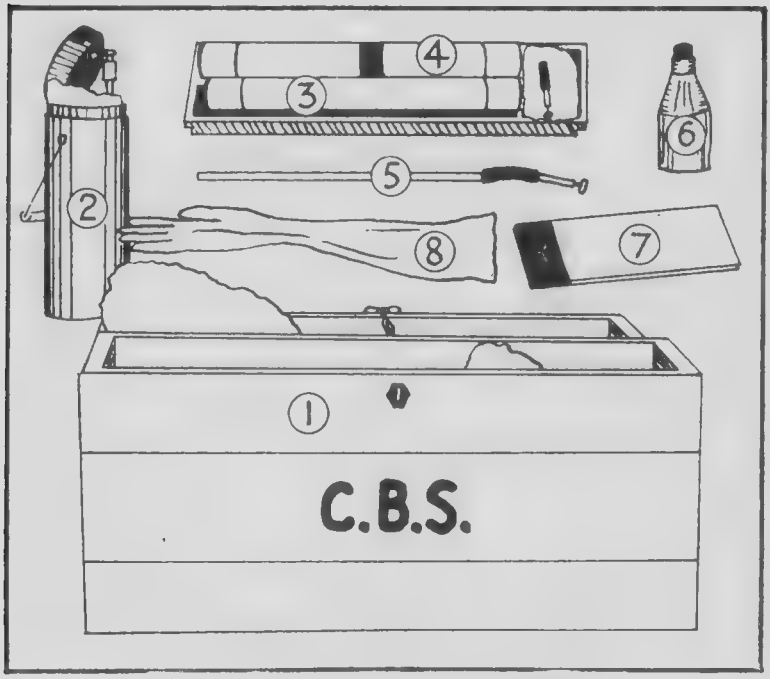


FIG. 12. Equipment box and contents laid out.

(1) Box; (2) thermos flask, containing semen tubes; (3) metal containers for dirty inseminating tubes; (4) banded metal container for clean inseminating tubes; (5) inseminating syringe; (6) tragacanth mucilage for lubricating hands; (7) inseminator's record book; (8) rubber gloves.

He takes out with him on his rounds only a little more diluted semen than he will require, leaving the remainder in the cool store where it will keep better. For example, if he has 5 Shorthorns and

4 Friesian cows to inseminate he will take about 8 ml. of diluted Shorthorn semen and 7 ml. of diluted Friesian semen. As 1 ml. is the dose injected, he will have two spare doses of each to use in case of accidents or for other cows which may be found on heat during his round. Any semen which is left over when he returns is thrown away, for since the tube will have been opened many times during the day its keeping quality may have been impaired. The tubes of semen taken on the round are placed in a large wide-necked thermos flask (Fig. 12 (2)) on a thick pad of cotton wool under which a few lumps of ice are placed. This gives a fairly even temperature of 5° C. throughout the day.

In the upper part of the box, a tray is fitted and this holds two metal containers (Figs. 12 (3 and 4)). One, marked with a red band round it (4) contains the sterilized thick glass tubes which are used for inseminating (see below) and the other (3) is empty to take the dirty tubes after they have been used. In addition, a small 2 ml. glass syringe fitted with a short, thick piece of rubber tube to take the inseminating glass tube is also carried (Figs. 12 (5), 13), together with an elbow length rubber glove to pull over the arm (Fig. 12 (8)), which is used for insertion into the rectum on inseminating. A bottle of tragacanth mucilage (6) for lubricating the hands and a record book (7) are also carried. It is advisable to carry also waterproof overalls and rubber boots.

FIG. 13. Apparatus used for insemination.
A small (2 ml.) glass syringe (Z) is fitted with a short piece of thick rubber tube (Y) into which is fitted a thick glass tube (X) with a narrow lumen graduated to 1 ml.

Insemination. Much time is saved in insemination if the farmers, in summer time, are asked to leave those cows to be inseminated tied up in the cowshed after the morning milking. If these cows are turned out to pasture with the rest there will be delay in getting them in and it will not be possible for the inseminator to do so many cows in the day. In case the cowman is away when the inseminator calls, it should be arranged that the cow to be inseminated should be marked in some way, for example, by a string tied to its tail, which the inseminator will remove when the cow has been done.

On arrival at the farm, a clean glass inseminating tube from the red banded metal case is fitted in the rubber end of the glass inseminating syringe. 1 ml. of the diluted semen in the tube carried in the thermos flask is then sucked up into the inseminating tube—to the mark made

on the tube—by slowly withdrawing the piston of the syringe. The motion should be slow so that the semen forms a continuous layer, unbroken by bubbles of air, which may be formed if the motion is too rapid. Care should be taken that the semen is not sucked up beyond the mark on the tube and that the syringe, and that part of the glass tube next the syringe, has air only in it. This will ensure that the syringe and rubber connection are uncontaminated with semen, which is necessary if they are to be used for another cow.

The rubber glove is then drawn on to the arm, which is to be inserted into the rectum of the cow and the area over the back of the hand and arm is lubricated either with a few drops of paraffin, gum tragacanth emulsion + alcohol, or soap and water. After the cow has been tied up the cowman is asked to stand on one side of her and to lift the tail *upwards* and to one side while the inseminator's hand is inserted into the rectum. This should be done with a slow steady pressure, the fingers being closed together to form a cone. If the rectum contains an excessive amount of dung, this can be scooped out before proceeding, care being taken to avoid soiling the vulva. Inseminations frequently have to be carried out with no help at all, the owner or stockman not being available. In such cases, the hand is inserted into the rectum with the *tail on the opposite side to the free hand.* This prevents the cow from waving the tail about and breaking the glass pipette. The various parts of the reproductive tract (see Fig. 14) lie immediately under the rectum and between it and the bones of the pelvis.

Before starting to inseminate, the reproductive organs should be palpated by gentle pressure of the fingers downwards on the wall of the rectum (Fig. 15).

Passing inwards the hand first feels the firm cervix (see Fig. 15), and then the division of the softer horns of the uterus will be felt. By swinging the finger tips sideways, first right and then left, the two horns of the uterus can then be palpated. These, in the non-pregnant cow, should be of approximately equal size; if one is notably larger than the other pregnancy may be suspected. Before inseminating it is necessary to make certain that the cow is not in-calf, for otherwise abortion is liable to be caused. It is surprising how frequently the operator is asked to inseminate a cow which is already pregnant. The mistake is often made because cows on heat jump one another and the wrong cow of the two is sometimes picked out as being the one on heat.

In some cases enlargement of the uterine horn is due to infection

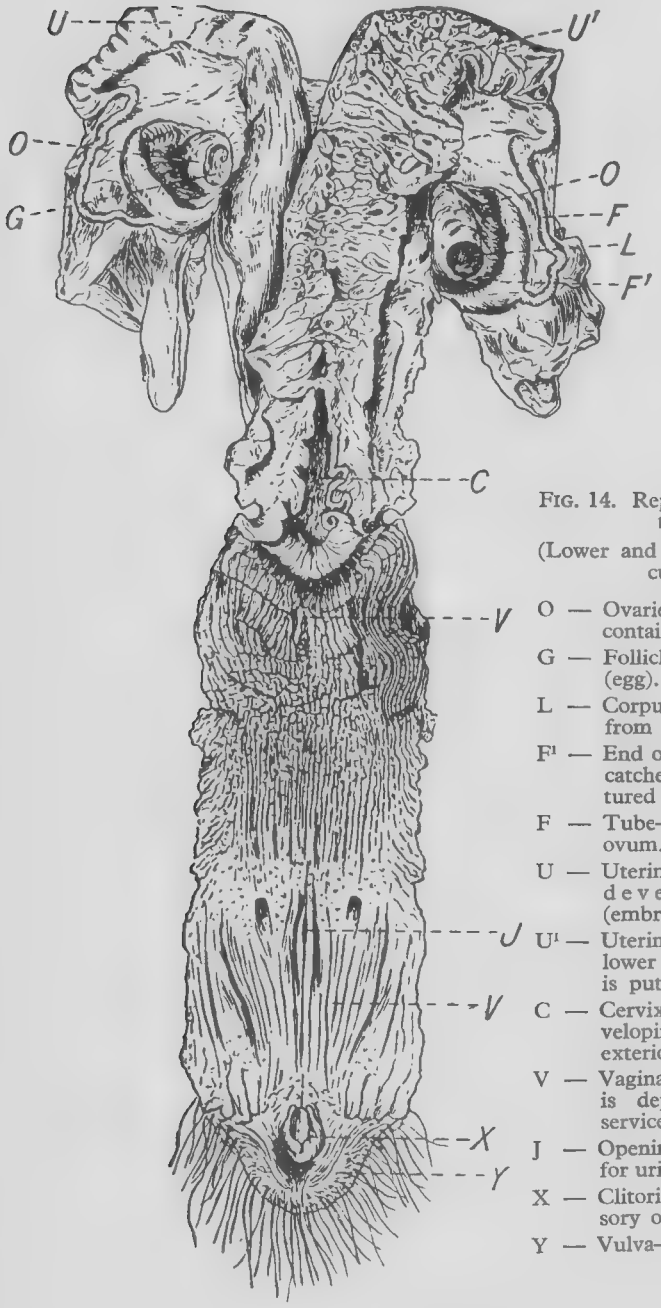


FIG. 14. Reproductive organs of the cow.

(Lower and right part of canal cut open.)

O — Ovaries—produce follicles containing ova.

G — Follicle—contains ovum (egg).

L — Corpus luteum — formed from ruptured follicle.

F¹ — End of tube or oviduct—catches ovum from ruptured follicle.

F — Tube—conducts fertilised ovum.

U — Uterine horn — nourishes developing ovum (embryo).

U¹ — Uterine horn cut open—in lower part of which semen is put on insemination.

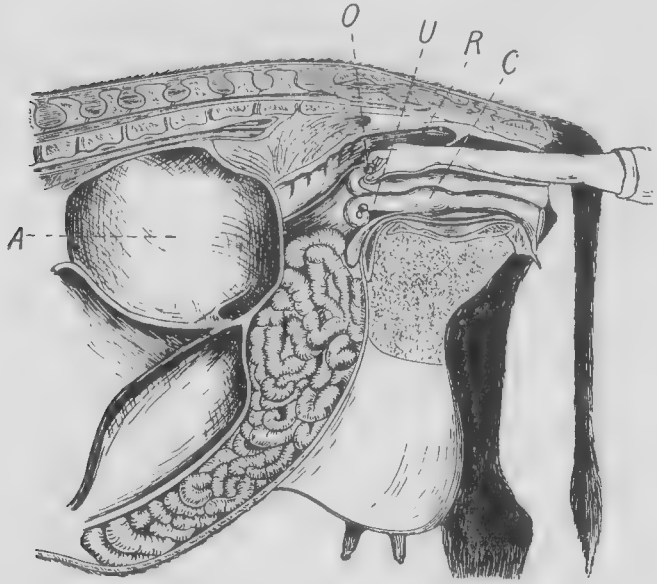
C — Cervix—shuts off developing embryo from exterior.

V — Vagina—in which semen is deposited in normal service.

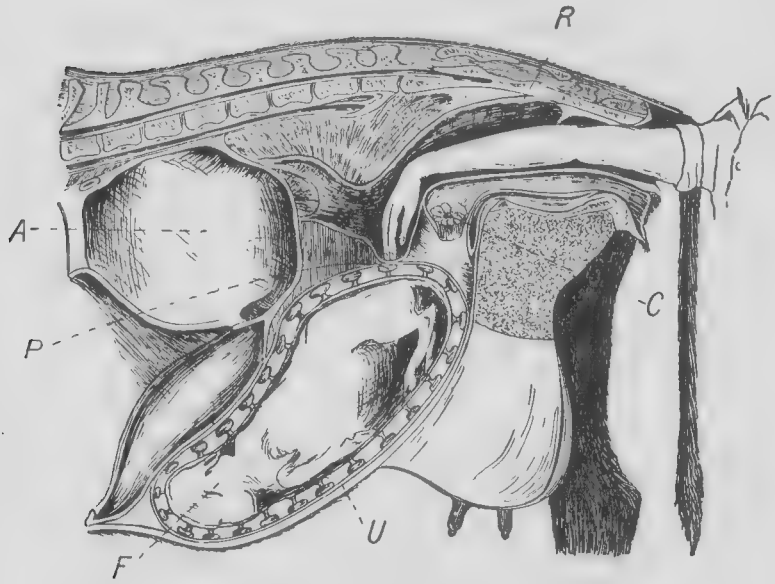
J — Opening of urethra—exit for urine.

X — Clitoris—erectile and sensory organ.

Y — Vulva—external opening.



(*a*) Non-pregnant.



(*b*) Pregnant.

FIG. 15. Palpating the reproductive organs per rectum.
O—ovary; U—uterus; C—cervix; R—rectum;
P—cotyledon; A—rumen; F—foetus.

and contains pus and not a foetus. This can be checked in two ways —either by gently rolling the distended wall of the uterus between the finger and thumb and, if the cow is pregnant, feeling the foetal membranes inside—like a shirt under the sleeve of a coat—or by inserting the other hand in the vagina and feeling between finger and thumb the thick consistency of the mucus which accumulates in the cervix during pregnancy (for further details see Appendix). In a cow on heat the consistency of the mucus is thin and watery.

Having made certain that the cow is not pregnant, the glass inseminating tube is gently inserted into the vulva with the other hand, taking care to keep it *pointing upwards on the roof of the vagina* and not on the floor, for otherwise there is danger that it may enter the urethra (J—Fig. 14) which lies on the floor of the vagina about five inches from the vulva entrance. When the glass inseminating tube reaches the top of the vagina and the entrance to the cervix (Fig. 16 (5)) the hand in the rectum is used to guide it through the narrow and tortuous cervix by hooking the dividing line between the two horns of the uterus with the middle finger and easing it down by drawing the cervix over the end of the glass tube. Should it happen that the pipette is accidentally passed into the bladder this may cause some temporary confusion. The point of the tube in such cases, however, can be felt passing forward beyond the cervix and can be deflected to one side and palpation will soon reveal that it is not in the uterus. It should then be withdrawn and a further attempt made with the top of the pipette directed upwards, and after making sure that no urine has got into the pipette.

When the end of the inseminating tube is just through the cervix, the piston of the inseminating syringe is pressed with the thumb of the hand holding the syringe and the semen is injected into the base of the uterus. Great care should be taken to see that the pressure on the piston is *slow and steady*, so that all the semen in the tube is forced in. If pressure is short and sudden, air bubbles will be forced in through the semen and it will be found that almost half the dose of semen is left in the tube, with the consequent lowering of the chances of fertility.

In order to obtain experience in the art of insemination it is advisable to practise on cows at an abattoir just before slaughter, inseminating the cow with a dye such as violet ink in place of semen so that the exact position in which it is placed can be seen after the cow is killed and opened up. The amount of fluid left in the inseminating tube can also be observed.

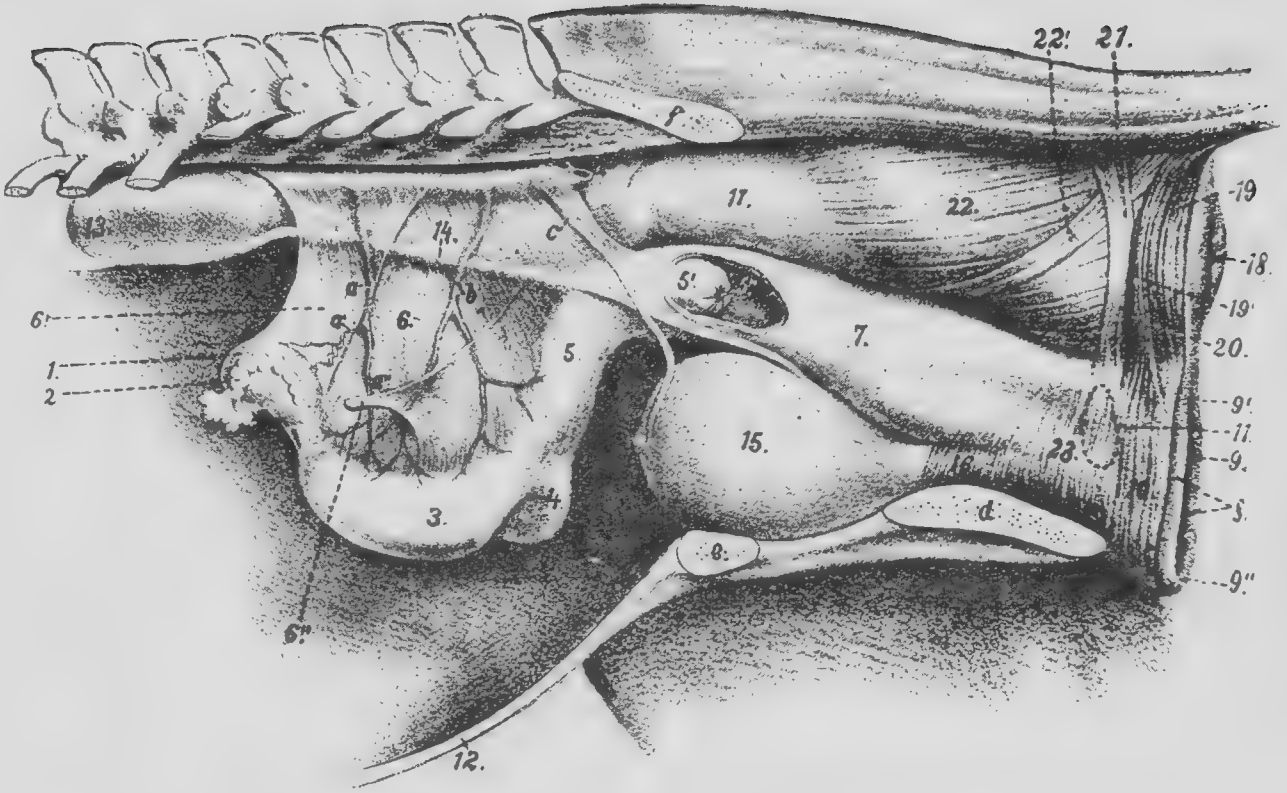


FIG. 16. Female reproductive organs (mare).

In normal service the semen is deposited in the upper end of the vagina (7), and only a small fraction of it finds its way into the cervix (5), but in artificial insemination the semen is put directly through the cervix and into the lower end of the uterus (3), and so less is required.

In normal mating the semen is sprayed over the external entrance to the cervix and most of it falls on the floor of the upper end of the vagina. From the cervix the sperms, by reason of their own power of movement, find their way into the uterus, through the horns and up the tubes. At the top of the Fallopian tube (Fig. 14) one of the sperms unites with, or fertilises, the egg cell, provided the latter is present. Most of the semen deposited in the vagina in natural mating remains in the vagina and is lost. By introducing the semen directly through the cervix as in insemination, very much less semen is required than in natural mating so that from one ejaculate of the bull some 10 to 60 cows can be inseminated, the exact number depending on the quality of the semen and other factors.

On completing the insemination the glass inseminating tube is removed from the syringe and put in the metal container for dirty tubes. It is essential that a separate clean glass inseminating tube should be used for each cow inseminated so that there may be no danger of carrying any disease from one cow to another.

The operator carries with him a service book and before he leaves the farm he fills up and signs a sheet (see p. 53) for each cow inseminated and hands it to the owner, a counterfoil in his book being entered up at the same time.

This service sheet provides the owner with particulars of the insemination. If the sheet is also signed by the owner with a guarantee that no bull has had access to the cow at this heat period, it may be forwarded as a certificate of service to the Breed Society so that the future calf may be registered either in the pedigree or grading-up register. Some Breed Societies accept these certificates.

Cleaning the apparatus. It is essential that all apparatus should be kept scrupulously clean. If this is not done infection may be spread from one cow to another, or from farm to farm. Also dirty glass ware may reduce the fertilising power of the sperm. Washing of apparatus is much easier and more effective if it is done as soon as possible after use—that is, while it is still moist and before the semen has had time to dry on it.

For rubber apparatus, such as the liner of the artificial vagina and the rubber cone, cleansing should be done by brushing thoroughly with hot, soft water. Washing soda may be used to remove the vaseline but, if used, all traces of it should be removed afterwards by thoroughly rinsing with running hot water. No soap should be used,

because soap is injurious to sperm. After washing, the rubber apparatus should be dried thoroughly by hanging in a warm, but not hot, atmosphere where it is protected from dust.

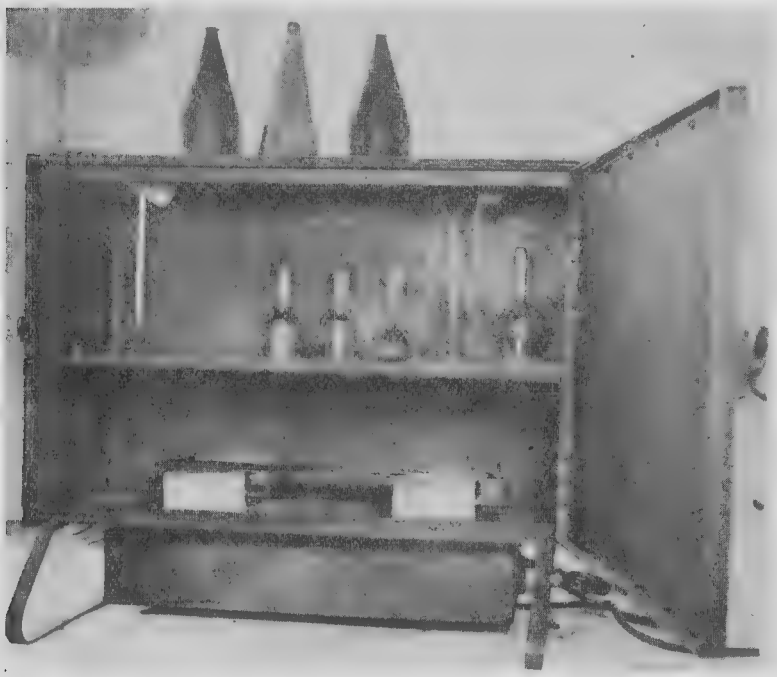


FIG. 17.. High temperature oven for sterilising glassware.

Glass equipment should be washed in the same way, and after washing should be sterilised by placing it in a high temperature oven (Fig. 17) and kept there, or in dust proof containers, until required for use.

ORGANISATION OF SOCIETIES

Regulations. Anyone can inseminate his own cows without a licence but, if semen is sold to others for insemination it is necessary to obtain a licence from the Ministry of Agriculture. There are two types of licence—Article 2 licences are issued to Societies who undertake to sell semen to farmers in a district, while Article 3 licences are only issued to individual pedigree breeders for a limited number of inseminations in other herds. The conditions attaching to the licence are more comprehensive for Article 2 than for Article 3 licences. For the former, the main conditions are that the bulls used should be of sufficient merit, that they should be free from diseases, such as contagious abortion, trichomonas infection, tuberculosis, etc., that the premises on which the bulls are kept should be isolated from other cattle, that the staff who are responsible for the inseminations are properly qualified to do the work, and that proper records are kept so that results can be checked at any time by officers of the Ministry. The regulations have been designed in order that artificial insemination should be used to improve the livestock, and not merely to make money out of the farmer.

Formation of Societies. As at present visualised, societies will fall into two categories, according to the method by which the necessary capital outlay is provided:—

(*a*) Private Centres in which the capital is provided by the members or by a number of individuals. Some of the first of these were registered under the Friendly Societies Act, but recently it has been decided that registration under the Industrial and Provident Societies Acts is more appropriate. A model set of rules has been drawn up and copies of these can be obtained from the Ministry of Agriculture.

(*b*) Centres run under the auspices of the Milk Marketing Board. The Board find the necessary capital and will administer the Society with the aid of a local management committee, elected by the members, in much the same way as the local branches of National Milk Records are run.

The Ministry of Agriculture, by recent legislation, is giving a guarantee to approved societies against losses incurred up to 1950, in expectation that these societies will help to improve the livestock of the country.

At the present time the number of societies that the Milk Marketing Board can set up is limited by the personnel available and by difficulties in building, but it is hoped it will be possible to increase the number of new societies set up each year. In the first instance, societies are being set up where the need is greatest, such as where there are a large number of cows in small herds in an area. It is also the intention that societies should be well distributed over the country, so that farmers in any part of the country can see one at work and form their own judgment as to their use.

The Committee of Management. By the rules under which the Milk Marketing Board operates its Centres, the Advisory Committee to any Centre for the first year of operations is nominated in the following way—three members from the relevant War Agricultural Executive Committee, three from the relevant county branch of the N.F.U., two nominated by the Milk Marketing Board, and one nominated from the relevant branch of the National Veterinary Medical Association.

Thereafter the Committee is elected by the members themselves at the Annual General Meeting. To help in the selection of bulls for the Station, the Committee of Management usually appoints a sub-committee for each breed involved; this may include one or more members of the Breed Society involved and a Veterinary Surgeon as well as the Livestock Officer and a man who can spend time looking carefully into the milk records of the animals involved.

In the initial stages it may be advisable to hold monthly meetings of the Committee as there will be many matters to be adjusted. Later, meetings every third month should be sufficient provided that the Chairman and one or two other members are given executive powers to deal with urgent problems arising between meetings. It is advisable for the Committee to obtain from the Veterinary Surgeon in Charge a report every three months so that the full working of the Station can be supervised and any defects put right in the quickest possible time. Such a report (see Fig. 18) should include such items as number of collections made from each bull, number of cows inseminated from each bull, number of cows which have failed to hold for each bull, number of inseminations made by each man working at the Station and the results of these. In this way a close check can be kept on all the activities of the Centre. It is advisable for the bulls to be seen by members of the Committee at regular intervals to ensure that their state is satisfactory.

CAMBRIDGE AND DISTRICT CATTLE BREEDERS' SOCIETY

Progress Report for May, 1944

KINGSWOOD HOMESPUN

No. of semen collections 14
Average volume ..... 5·2 ml.
New cows inseminated with K.H. semen ..... Non-pedigree 100
Pedigree 4
Reinseminations from previous services ..... Non-pedigree 35
Pedigree 1
Conception rate ..... 65·8%

TERLING FORMIDABLE

No. of semen collections 6
Average volume ..... 3·75 ml.
New cows inseminated with T.F. semen ..... Non-pedigree 32
Pedigree 2
Reinseminations from previous services ..... Non-pedigree 8
Pedigree 0
Conception rate ..... 68·2%

ORMA SPECIAL BLEND

No. of semen collections 21
Average volume ..... 3·75 ml.
New cows inseminated with O.S.B. semen ..... Non-pedigree 100
Pedigree 0
Reinseminations from previous services ..... Non-pedigree 49
Pedigree 3
Conception rate ..... 61·2%

HISTON ROSEMARY LORD

No. of semen collections 11
Average volume ..... 5 ml.
New cows inseminated with H.R.L. semen ..... Non-pedigree 153
Pedigree 5
Reinseminations from previous services ..... Non-pedigree 63
Pedigree 2
Conception rate ..... 67·6%

HISTON DAIRY KING

No. of semen collections 4
Average volume ..... 4 ml.
New cows inseminated with H.D.K. semen ..... Non-pedigree 8
Pedigree 0
Reinseminations from previous services ..... Non-pedigree 2
Pedigree 0
Conception rate ..... 59·8%

ANWICK TODDY

No. of semen collections 6
Average volume ..... 3·4 ml.
New cows inseminated with A.T. semen ..... Non-pedigree 11
Pedigree 0
Reinseminations from previous services ..... Non-pedigree 4
Pedigree 0
Conception rate ..... 67·2%

New cows inseminated in May 415
Total No. of cows inseminated up to 31.5.44 2813
Total mileage for May 7524
Average mileage per new cow in May ..... 18·13
Total No. of members to 31.5.44 514

FIG. 18. Report form of Society.

In starting a Society it is advisable, as in running-in a new car, to go slowly at first and not strive for a large membership until the administration has got into working order. In most areas the seasonal demand for services is greatest during the winter and early spring months in order to produce autumn calvers for winter milk. When possible, therefore, it is advisable to start a Society during the summer months when the demand is not so great. The Committee should study the rising demand for insemination due to the season or otherwise and be prepared to meet the demand before it arrives by the purchase of bulls. If the Committee wait till the demand comes before taking action their bulls are liable to be overworked and trouble will ensue. They should in the same way make provision ahead for an adequate number of inseminators, and not forget the possibilities of sickness among the staff. Holidays for the staff are best arranged during the "slack" season of the year, mostly in the late summer months.

Location of Centre. To ensure the economic success of the Station it should, within a year or two, be dealing with a minimum of about 4,000 cows a year, that is, at 25s. per cow it should have an income of £5,000 per year. Since in most districts about half the cows are in herds of 15 or less, and these small herds will contribute most to the Society, there should be at least about 10,000 cows within the area to be covered by the Society. The regional officers of the Milk Marketing Board have maps showing the distribution of dairy herds in the area and these are useful for planning the actual location of the Station, which should be somewhere near the centre of the cow concentration at a site where roads radiate outwards to thickly populated cow areas. If the number of cows required can be obtained within a 10-mile radius of the Centre, the Centre will work much more economically than if it is necessary to go to a 15-mile radius—for under these conditions there is not only a saving of petrol and transport, but also a saving of the inseminator's time so that one inseminator can do many more cows in the year. It is inadvisable to go beyond a 20-mile radius from a Centre, for costs, owing to these causes, go up at an ever-increasing rate with each mile added to the radius. Where there is a high concentration of cows just outside the normal area covered by the Society, it is better to set up a sub-station to deal with such a concentration, rather than to extend the whole area of the Society. Semen from bulls at the Centre can be put on rail (or sent by car) to the sub-station each morning, where it can be distributed

within the sub-station area. For example, a concentration of cows round Guildford is at present being served by a sub-station of the main Centre at Reading, some 25 miles distant.

Buildings. The bulls should be kept in buildings completely isolated from all other cattle, so that there shall be the least possible chance of the spread of the infectious diseases of cattle, contagious abortion, trichomonas infection, foot and mouth disease, etc. The site should be supplied with water, electric light, gas and telephone so that proper laboratory facilities can be provided. As a temporary measure existing buildings—such as stables, may be adapted for bull accommodation, but, unless the necessary adaptations are small, it is preferable and best in the long run, to erect special buildings for the purpose. A suggested lay-out for a set of buildings would be as shown overleaf (Fig. 19).

The exact design of the layout will naturally vary with the site and existing roads, etc., but the essential principles which determine the layout are as follows:—

An office is required where telephone calls can be received and records kept of inseminations made; this should be fitted with filing cabinets, typewriter and usual office equipment.

A laboratory supplied with gas and/or electricity for lighting and heating is necessary. Here all the glass ware and instruments which are required can be washed, sterilised and prepared for use or stored until required. Supplies of materials are also kept in the laboratory, which should be well furnished with cupboards, drawers and shelves. The bench should be fitted with lighting plugs for the microscope and gas taps for Bunsen burners. There should be a laboratory sink with water taps and an instantaneous water heater. A dry-heat steriliser for glass ware is required. There is also required a refrigerator which can be set to a controlled temperature of about 5° C. for storing semen until use.

A washing room and cloak room for the staff is desirable so that after coming off their rounds on farms they can change their boots and overalls and have a clean-up. A supply of suitable disinfectant, such as Dettol, for the hands, should be available, but great care is required to see that no disinfectant is carried by the hands into glass ware or apparatus used for the collection and storage of semen.

A collecting room, containing the service crate into which the teaser cow can be put for collections from the bull, should be under cover.

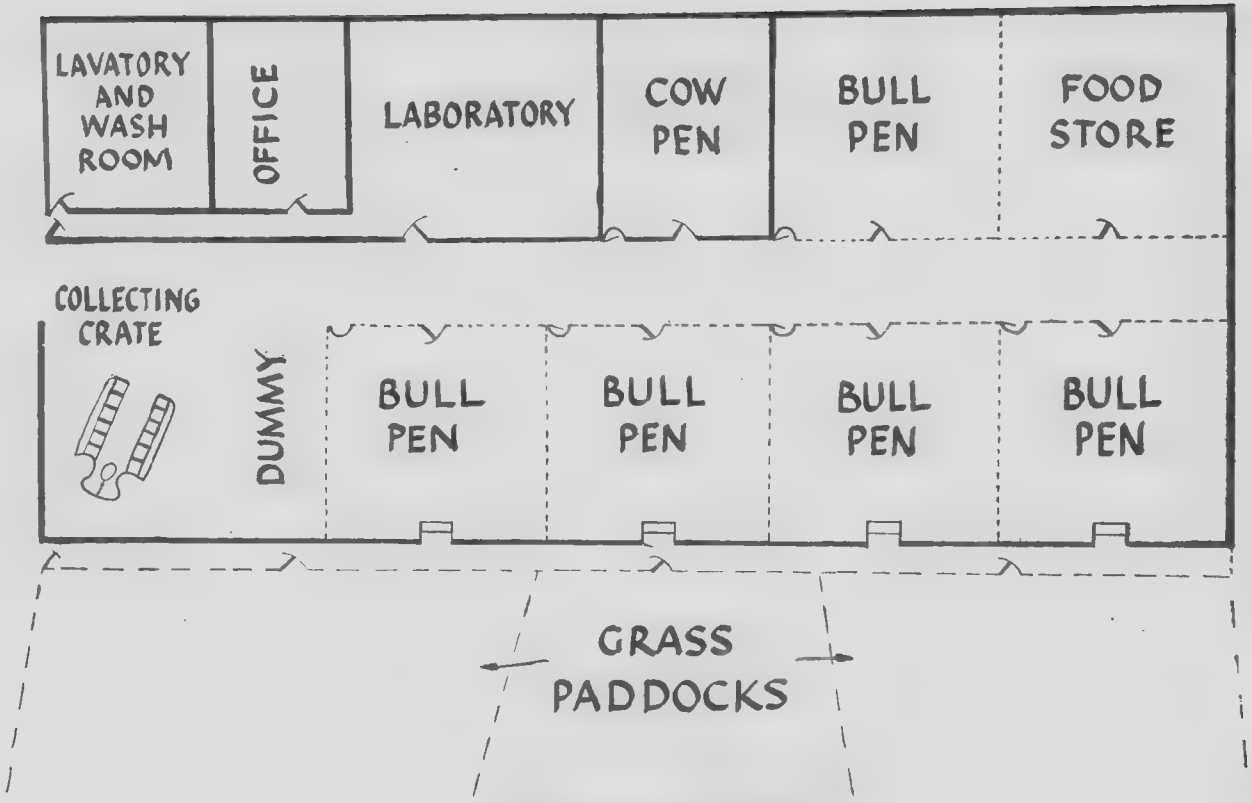


FIG. 19. Plan of buildings.

It is a good plan to have the collecting room under the same roof as the laboratory so that the apparatus can be kept dry on wet days. It is also as well to have it within sight of the bull pens so as to keep the bulls not being used at the time interested in their work. In the collecting room a dummy cow can also be kept for use in case anything goes wrong with the teaser cow, or as an occasional change for the bulls. The floor of the collecting room should be made of some non-skid material such as chalk rubble in order to prevent the bulls from slipping. It should also be made of a substance which will not injure the feet of the bulls. The service crate and dummy cow are best fixed firmly to the ground with iron bolts set in blocks of cement—so that they can be moved to another position if, and when, required for awakening interest in the bull.

The bull pens should be so arranged that the bulls can see each other clearly and also if possible so that all can see the collections being made. For this purpose the inside divisions between the pens are best made of tubular steel so that the animals obtain a clear view of one another all down the row. Non-skid concrete floors with a slight fall to a drainage channel at one side facilitate cleaning-out, while a water bowl and feeding trough with a mechanism for catching the bull during feeding are desirable. If the bull pens are not roof-lighted, windows should be guarded with *vertical* iron bars so that they do not get broken. It is desirable that each bull pen should have a run-out grass paddock attached; the lifting swing door is a very useful type to fix between the bull pen and paddock.

The grass paddock is an advantage as it not only supplies exercise ground, but also a supply of fresh green food in summer. The paddock requires to be of sufficient size to prevent poaching—about 1 acre—and should be strongly fenced, preferably with stout wood. If fitted with a rubbing post it will save the fences and doors from injury from the bull. If space for bull paddocks is not available other forms of giving exercise, such as a circular power driven exerciser (Fig. 20, page 36), or an overhead wire line may be used, or in the case of quiet bulls they may simply be tethered on grass.

It is advisable to have, in addition to the line of bull pens, two wholly enclosed and separate boxes—one for the teaser cow, which is best kept out of sight of the bulls until required for use, and the other as an isolation box for a newly purchased bull or for a bull which may be under suspicion for a disease such as tuberculosis.

FIG. 20. Circular bull exerciser.

A food store is also required as it is convenient to purchase both hay and concentrate food in bulk. In the initial stages of a Society, while it is still in the process of obtaining members, a bull pen or pens can be used for this purpose: this will allow for expansion in numbers of bulls at the same time reducing the initial cost until the Society is well established. A garage for keeping cars will also be necessary, unless the inseminators have their own cars and are paid a mileage allowance. One car for each inseminator is required. It may be possible, later, to fit each car with a wireless receiving set so that late phone calls for inseminators can be put through to them. At present this is arranged by fixing a place at which the inseminator can call on his round for late calls.

Staff. Under present regulations it is necessary for each station to be under the direction of a qualified *veterinary surgeon*, who may also do some of the work of collection and insemination.

It is preferable that these veterinary surgeons should be employed full time at the station, for in such a station it is necessary that constant supervision be given to operations. If the veterinarian in charge of a station has a private practice in the district it gives him an unfair advantage over other veterinary practitioners in the area, and he may be tempted to favour the one activity to the detriment of the other. The duties of the veterinary director of the station are to supervise the staff, and see that precautions are taken against the spread of disease, not only in the bulls at the station but also by the staff going round farms. He will himself visit, as far as possible, all fresh herds joining the Society, and acquaint himself with the breeding records and health of the animals, and when any particular herd is having difficulty with fertility he will do the inseminations there and, if necessary, suggest to the owner that he gets his own veterinary surgeon to treat the cow for whatever disease or condition is causing the trouble. The veterinary director will also decide, on the sperm counts or fertility performances of different bulls, when and how often they shall be collected from, and will see that they are kept in proper breeding condition. He will keep under continual observation the fertility records of the different bulls in use (see p. 57) so as to detect at the earliest possible moment any falling off in fertility, and if and when this occurs will treat the bull to bring it back to full fertility. He will also arrange the rounds of the different lay inseminators each day and from records kept in the office (see p. 52), see that the lay inseminators, and particularly those

who are newcomers to the job, are obtaining good fertility results in the cows they are doing, so that if a man is not doing his job properly, he can quickly be stopped before much harm from delay in getting the cows into calf is allowed to occur.

It would be part of his duties also to watch the increase in the numbers of cows inseminated each month and from this, and from known seasonal variation in the number of cows which are put to the bull, to estimate the number of inseminations which will be required some three or four months in advance. He will then advise the Committee of Management as to whether one or more additional bulls will be required so that they can look round for them and have them by the time they are required. For this purpose it is useful to keep a chart showing the number of cows inseminated each month (Fig. 21).

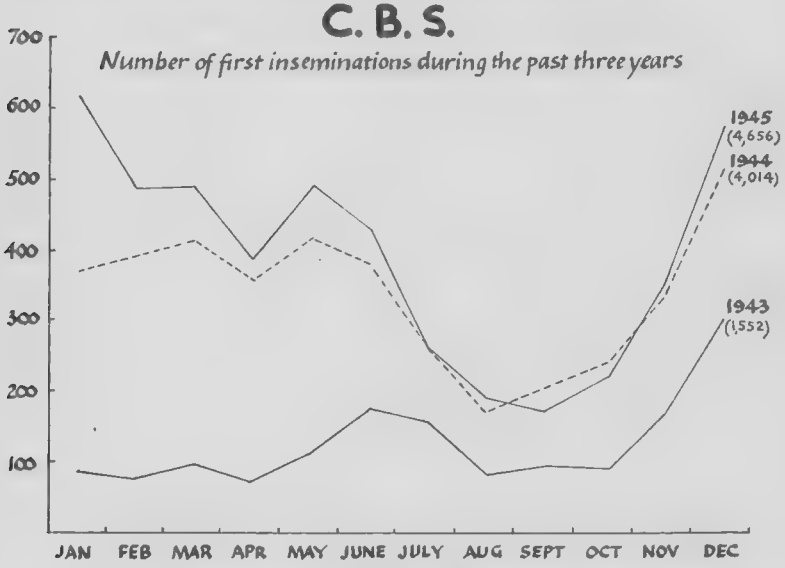


FIG. 21. Chart of number of cows inseminated each month. (Cambridge centre.)

With an extension in the number of Artificial Insemination Centres throughout the country it may be possible in the future for a Veterinary Director to supervise two or more adjoining centres. This would reduce the costs at each centre and would allow of better payment for an experienced veterinary surgeon. When this is done, one of the lay inseminators (see opposite) could be appointed as business manager and

take over many of the duties of the Veterinary Director as outlined above. This arrangement should offer capable lay inseminators a chance of advancement and an inducement to become proficient in all branches of the work.

The *lay inseminators*, who go round to the farms and inseminate the cows should be properly trained in their work, for on their efficiency will depend the success of the whole undertaking. Their work is hard and exacting, for it entails being out in all weathers and for long periods of time, so that they should preferably be young active men with an interest in livestock. A young man who has been through a course at a Farm Institute and wants to specialise in dairying would find such a post interesting and of advantage to him in his future career.

The number of lay inseminators required at a station will depend largely on the number of cows to be dealt with and on their density within the area covered. Where the cow population is not very dense (20 acres to a cow) and the radius from the Centre is large (20 miles) an inseminator would be required for about each 1,500 cows, whereas where the cow population was dense (5 acres to a cow) and the radius covered small (7 miles) an inseminator could probably deal with 3,000 cows in a year. In estimating the number of inseminators required some provision should be made for relief during holidays and for the possibility of illness. This can be done by arranging with adjoining stations for emergency help, or by allocating the Veterinary Director only a few animals to inseminate, so that in an emergency he can take on many more, or by having a manager or stockman trained to act as reserve. As the work of insemination in most areas tends to be seasonal it is advisable to arrange holidays in the slack months of the year (see July to November in Fig. 22). Before a lay inseminator is appointed he has to be approved by the Ministry of Agriculture as being properly trained (see Training below). It is possible that in the future a register of trained lay inseminators, entry to which is obtained by examination and by results of work in the field, might be set up.

It is necessary for a lay inseminator to be provided with a car. A car is preferable to a motor cycle as apparatus has to be carried and the work entails going out in all weathers. It is, perhaps, best for the inseminator to own his own car and to draw a travelling allowance rather than to use Society cars, for a car driven by different people is difficult to keep in order.

The duties of a lay inseminator may include collecting regularly from a particular bull or bulls, if allocated to him by the Veterinary Director in charge. It is essential (see Bulls, p. 48) that one man should collect from a particular bull regularly so that he learns the bull's likes and dislikes and so knows how to treat him—just in the same way that a stud-groom knows and uses the stallion he travels. If allotted a bull to collect from he would be responsible for studying the behaviour of the bull in question and of letting the Veterinary Director in charge know, at the earliest possible moment, of any abnormal behaviour on the part of the bull, so that it could be looked into before any serious defect developed.

When all the calls for the morning have come in—about 10 a.m. or such other time as the Station would decide—the inseminator would be allotted the number of herds he was to visit that morning and given the order in which he took them so that the Station Office would know where he was to be found if late calls in his area came in. He would then take his box of equipment and see that he had all the things required, together with the appropriate number of doses of semen from the bulls properly labelled, together with a little surplus for extra cows which might be notified to him on his rounds. He should see that his equipment is properly cleaned and in working order before starting out. With him he also takes a book of receipt forms and counterfoils, and as the cows are inseminated the details (see p. 53) are filled in on this, and given to the farmer. The book with counterfoils is handed into the office when he returns and the details from the counterfoils are entered in the files by the office assistant next day, while the inseminator takes another book with him on the next day. Thus the inseminator uses two receipt books, each one on alternate days. It is advisable for an inseminator to take as far as possible the same area each day, so that he knows exactly where each farm is and where the cows are: this saves a lot of time. If he gets to know the herd well he can, if it comes to the choice of two different bulls' semen, use the one which the farmer prefers and by personal contact with the owner and milker can arrange things to meet conditions on the farm. For example, he will know exactly where the cow on heat is to be found, for in summer the owners should be asked to keep the cows to be inseminated tied up in the shed and not turned out to grass with the others, as this saves time. He will also know where to obtain a pail of water should the cowman be away on the fields. In winter, too, it may be possible to mark in some way (such, for example, as tying a

piece of string on the tail—which is removed by the inseminator after insemination) the cows on heat if the cowman has to be away and to know the place where he leaves the insemination receipt form. All these things help to save time and allow the inseminator to do more cows in a day and thus to reduce costs. In some Societies in U.S.A. the inseminator is paid a basic annual salary of so much for the insemination of 1,250 cows and given additional payments for all he does above this number. This encourages him to develop time-saving devices and compensates him for overtime put in in the rush periods of the year. The exact number of cows on which the basic rate should be paid would naturally vary with the density of the cow population in the area (see p. 39). On returning from his rounds the inseminator should, according to arrangements made at the Station, either immediately clean all the apparatus he has used, or hand it over to a girl in the laboratory for this purpose. It is important that this should be done before the semen in the apparatus (inseminating tubes, etc.) has time to dry on it, for then it becomes much more difficult to remove.

A *Secretary, and person in charge of the laboratory equipment* is required to take charge of the office work and apparatus. This, according to the size of the Station, can be done by one or more girls

The Secretary would keep all the records (see p. 51) and accounts of the Society, take minutes at the Committee Meetings and send out notices to members. She would issue receipt books to the inseminators each morning and collect them when they come back, entering the details in them on the permanent records next day. Either she, or the person in charge of the laboratory, would be responsible for cleaning all the artificial vaginas, glassware and other apparatus used, for sterilising the inseminating tubes, drying thoroughly all the rubber apparatus and issuing it to the inseminators as they require it. She would also be responsible for ordering fresh stocks of equipment and seeing that reserve stocks are held, for the supply of eggs and phosphate solutions for the dilutions, as well as seeing to the running of the refrigerator. It would be a matter of arrangement as to whether she or one or other of the inseminators or the Veterinary Officer in charge did the sperm counts on the bulls: this would be determined by the size of the Station and the training of the personnel.

A *Stockman* in charge of the bulls is required: he should be properly trained in the management and feeding of bulls, for much will depend on the health and proper functioning of the bulls. It is essential that

the stockman should live at, or very near, the Centre, so that he is available if necessary by night as well as by day. He should be responsible for the fitness of all the bulls and should report immediately to the Veterinary Officer in charge anything abnormal in any of the bulls under his charge. If one of the lay inseminators employed at the Station is suitable for this work he can undertake it in addition to his other duties: in which case a farm worker could be employed to do the actual manual work of feeding, cleaning out, exercising, grooming, etc., under the stockman's direction. If a man is appointed in the first place as a stockman only, it would be useful to train him as an inseminator also so that he can, in an emergency, also undertake this work.

Bulls. The importance of the proper selection of the bull for the successful breeding of dairy cattle and the way in which "proven bulls" (that is, bulls whose daughters give yields above the average of the breed (see Figs. 22, 23_2 pp. 44, 45)) can be used in the improvement of dairy cattle have been described in Pamphlet No. 12 on the "Improvement of Cattle" published by the Bath and West and Southern Counties Society, July, 1944—to which the reader is referred for information on this subject.

In order to determine *which breed of bull* should be kept at a Centre, it is advisable to make a survey of the number of the cows of the different breeds in commercial herds in the area to be covered by the Society. To begin with, bulls from the two most numerous breeds should be used, and later bulls of other breeds added when the probable demand for them approaches 1,000 cows a year. For satisfactory working of a Society there should be at least two bulls of each breed selected so that in case for any reason one bull ceases to function there is always semen from that particular breed available. Where there are 1,000 cows of any one breed to be inseminated it becomes a commercial proposition to keep two bulls of that breed, but where the number of cows of any one breed is much less it would not be profitable to keep two bulls. Where the number of cows of one breed in the district is approximately 500 it would be profitable to keep one bull only of that breed, provided that an arrangement could be come to with a neighbouring centre whereby they would supply semen of that breed in an emergency. Thus, for example, if two adjoining Centres had only about 500 Jersey cows in each of their areas, it would be possible for them to keep only one Jersey bull each and agree to exchange semen in the case of one of the bulls not functioning properly.

The *number of bulls required* at a Centre will depend on various circumstances. On the average it can be taken that a bull is required for each 500 cows in the Society, but where a Society is just starting it must have more bulls than is necessary at the time in order to allow for increase in membership, while when a Society has obtained static membership and/or where there are a lot of cows of one breed within the Society (necessitating the keeping of 3 or more bulls) then the number of cows per bull can be increased without danger of breakdown.

Bulls vary considerably in their sperm production, just as cows do in milk production, and in selecting bulls for artificial insemination, other things being equal, care should be taken to select those which produce plenty of active sperms. In general, young bulls, under two years old, and old bulls, 9 years old and over, giver fewer sperms than bulls in the prime of life from 3 to 8 years, although there are many exceptions to this general statement.

In *the Selection of bulls* for an artificial insemination station the three main items to be considered are (*a*) that they will get high-yielding heifers of good type, (*b*) that they are fertile animals, and (*c*) that they are free from disease.

For certainty that they will breed high-yielding heifers of good type, there is nothing better than a proven bull, that is, a bull who has daughters already in milk, which have averaged a yield above that of the breed average (see Figs. 22, 23). Until progeny testing becomes automatic (as milk recording is with cows) in this country, however, there will be great trouble in finding these bulls. A bull will be 6 years old and over before he can have daughters in milk and only a small proportion of dairy bulls are at present being kept to this age. The next best thing to a proven bull is the son of a proven bull out of a cow which has milked and bred well. For this purpose it is to be hoped that we shall in this country have lists of proven bulls of all breeds published annually as they have been in Denmark, Holland, U.S.A., New Zealand and elsewhere.

Failing a proven bull or the son of a proven bull the best method of selection is that based on the lifetime milk and, if possible, butter-fat records of the dam and the two grand dams: all these should be well over the average figures for the breed. Needless to say the bull and ancestors should be of good breed type.

Probably the cheapest and most suitable bull for an Artificial Insemination Society to buy is a bull of 4 to 5 years old, which complies with the preceding requirements, rather than a young untried bull.

Such bulls are usually owned by willing sellers in that at that age they are getting difficult to keep, their own daughters are just ready for service and so the owner wants to change his bull and the bull is getting too heavy to serve heifers without a service crate. Moreover, the daughters of such a bull can be seen and some estimate can be made of the sort of stock he is breeding, while it will only be about a year

FIG. 22. A proven bull.

Average yields of the daughters of Terling(Im* 22) Marthus R.M.

123 — 1st calf,	daughters	averaged		10,602	lbs.,	3·41%
115 — 2nd	,,	,,	,,	13,796	,,	3·34%
102 — 3rd	,,	,,	,,	14,918	,,	3·35%
87 — 4th	,,	,,	,,	15,354	,,	3·38%
61 — 5th	,,	,,	,,	16,150	,,	3·28%
45 — 6th	,,	,,	,,	16,830	,,	3·26%

before his daughters come into milk and it will be known whether he will qualify as a proven bull. It is a good plan for a Society to have in each breed a proven bull which is given first preference and is used to utmost capacity, using the 4 to 5-year-old bull as a reserve to do those cows which the proven bull cannot manage, until such time as the 4 to 5-year-old bull becomes proven good or bad for milk production, when he can either become the leading bull at the Station or be sold to the butcher without having done much harm in the district.

Owing to the difficulty of obtaining proven bulls at present it may suit a Society to prove its own bulls by buying a young bull with a

FIG. 23. Daughters of a proven bull.

Eight cows by Wild Dairyman 2nd in the Cambridge University Farm herd that averaged 1,143 gallons of milk in the same recording year.

promising pedigree (as outlined earlier) and inseminating from him a limited number of cows, distributed among a large number of members so that no one member is harmed if he does not breed well for milk. For this purpose some 200 to 400 cows would be sufficient and then he could be sold or hired to a breeder with a disease-free herd on condition that the Society had the option of taking him back when his daughters came into milk. The best time to use such young bulls for test inseminations is during the peak period of the year for services (see Fig. 21); he can then act as an extra reserve bull at the busy period.

Under present regulations all bulls used for artificial insemination in herds other than those kept by the owner of the bull have to be "passed" by a Ministry of Agriculture Livestock Officer as being of superior merit before the licence to use for this purpose is given. Similarly, the bull has to be "passed" by the Ministry of Agriculture Veterinary Officer for fertility and for freedom from disease—tuberculosis, contagious abortion, trichomonas infection and other genital diseases. Some indication of the bull's freedom from trichomonas infection is obtained by the regularity of breeding in the herd of cows on which he has been previously used. When bulls of 4 to 5 years old are purchased there is an added danger that, having perhaps been already used in two different herds, they may have become infected with disease. This is the reason why such bulls should have a detailed veterinary examination before being used for artificial insemination purposes.

In a Society, just as in a private herd, the owners will not want to inbreed, and so a bull used at a Centre should be changed after he has been used there for about $2\frac{1}{2}$ years, i.e. when his daughters come of breeding age. The normal expectation of life of a dairy bull is some $10\frac{1}{2}$ years, so that if he is managed properly, a bull proven at six years old could on the average be used by two Artificial Insemination Societies in succession.

The *method of feeding and management* of the bulls is important for it determines the length of useful life of a bull. In the early days of the formation of Artificial Insemination Societies in this country and U.S.A. much trouble and many disappointments were caused by lack of knowledge concerning the way in which bulls at Centres should be fed and managed.

Bulls are best kept in a hard thriving condition, in good flesh but not fat. To do this it is best to feed the bull well but to give him enough exercise to work off surplus fat (for methods see p. 35). Where

much exercise is not given extra care is required to see that the bull has sufficient proteins and vitamins without too much surplus carbohydrate to make him fat. Some green fodder, grass or lucerne in summer, and kale in winter, to supply vitamins (particularly vitamin A) and good hay *ad. lib.* should be fed, while a daily concentrate mixture of bean meal 2 lbs., crushed oats 2 lbs., linseed cake 1 lb. and fish meal 1 lb., given in two feeds, has been found to give satisfactory results with Shorthorn and Friesian bulls. According to Russian experiments roots and fresh grass increase the sexual activity and

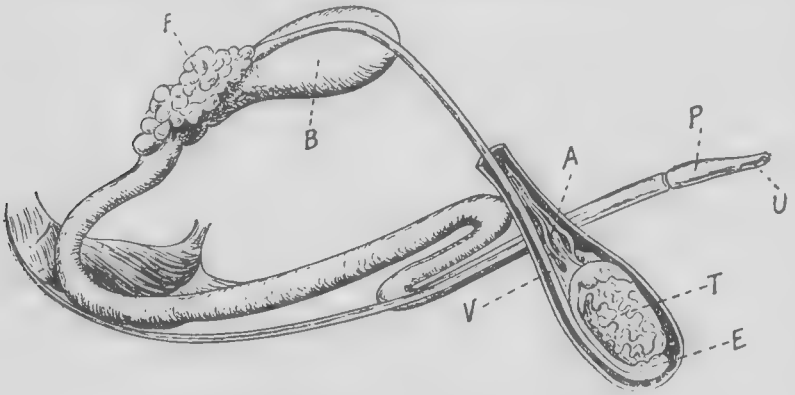


FIG. 24. Reproductive organs of the bull.

A — Blood vessels in scrotal cord supplying testes.
T — Testis—forms sperms.
E — Epididymus—stores sperms.
V — Vas deferens—conducts sperms on ejaculation.
F — Vesicula semenalis—supplies fluids diluting sperm on ejaculation.
P — Penis—intromittent organ.
U — Opening of urethra—conducts semen, and also urine from the bladder.
B — Bladder—stores urine.

volume of the semen but do not affect the density or viability of the sperms.

Experiments in U.S.S.R. and Denmark show that a high protein content in the ration is important for the production of plenty of sperm with good fertilising power. According to Russian experiments a bull requires 0·1 lb. starch equivalent and 0·1 lb. digestible protein above his maintenance ration for each service performed. A bull is best used some two hours after a meal: there is a tendency for him to be slow if it is attempted to collect from him immediately after a full meal. Grooming helps to keep a bull fit.

The reproductive organs of the bull are shown in Fig. 24.

Proper management of the bull at service is essential if keenness to serve and a good quantity of active sperms are to be maintained. Vigorous service and good quality of semen do not necessarily go together. A bull may be quite vigorous at service but if the testicles are not producing plenty of active sperms the mating will be sterile and the semen worthless for insemination. This condition of defective sperm production may sometimes be corrected by better feeding and management, but in most cases a bull with low sperm production does not respond to treatment and is best sent to slaughter. The veterinary test mentioned on p. 46 should safeguard the insemination centre against the purchase of bulls with poor natural fertility. The type of infertility which causes the most difficulty at insemination centres is that caused by nervous trouble (psychological infertility). When purchased the bull may be physically sound and the testicles may be producing an ample supply of active sperms and when collections are first made good samples of semen are obtained. However, after a shorter or longer period the bull begins to show diminished sexual activity. Service becomes slower, the thrust less vigorous and the semen sample weaker. Eventually the bull may refuse even to mount the cow and may have to be discarded from the Centre. On return to natural mating the bull recovers completely and his services are quite fertile. This disinclination to serve at insemination centres is largely caused by lack of skill and experience in handling the collections of semen, but some bulls are particularly sensitive to artificial collection, while others appear to be very resistant to even rough handling.

The sexual nervous system of bulls has only recently been made the subject of research in the U.S.S.R., but some general principles have already emerged and give greater understanding of the causes of psychological infertility and how to avoid it.

The bull performs instinctively certain mating movements such as mounting the cow, protruding the penis, thrusting, and ejaculating semen. These movements are known as reflexes. Reflexes can be either reinforced and made stronger and more vigorous, or inhibited and made weaker. Sexual reflexes are reinforced by pleasurable sensations which accompany their performance. Hence, a bull which is used for service regularly and at reasonable intervals will perform the reflexes more vigorously and more quickly; that is to say, he learns to serve quickly and efficiently. Reflexes which are accompanied by pleasurable sensations are reinforced if repeated in familiar surroundings: that is to say, the bull learns to prefer service in the same

place, if attended by the same stockman and so forth, and he may be "put off" service if the surroundings are unfamiliar or if there are distracting influences. Sexual reflexes are also strongly reinforced by periods of sexual rest. If the bull is used too frequently on one day the reflexes become weaker, but if not used for several days the bull may be much keener and more active.

The above conditions, which reinforce the sexual reflexes are those mostly met with in natural matings and are familiar to the stockman. Now collection with the artificial vagina reproduces some of the conditions of natural mating and the reflexes of collection may become reinforced in the same way as the reflexes of natural mating, but the use of the artificial vagina also introduces conditions which tend to inhibit sexual reflexes. The sexual reflexes are inhibited if their performance is accompanied, not by pleasurable sensations, but by sensations which are painful, uncomfortable, or even merely distracting. It is not surprising, then, that collection with the artificial vagina may give rise to some inhibition or weakening of the sexual reflexes. In very sensitive bulls inhibition may arise quite quickly, even when the collection is taken most carefully. Repeated careless collection will "put off" the most hardy bulls. Inhibitions will be reinforced the more often the unfavourable conditions are repeated at collection, and the shorter the interval between collections. It follows from this that to prevent the development of inhibitions, collections should not be taken more often than is necessary; and secondly, it follows that if inhibition has started it is a great mistake to persist with unsuccessful attempts at collection. Repetition will only reinforce the inhibitions. The animal should be given a rest from collections for as long as possible. Inhibitions are also reinforced if repeated in familiar surroundings. The bull learns to associate the discomfort or inhibiting condition with what is near him at the time. It may be the sight of the artificial vagina, the colour of the teaser cow, the presence of the collector, and so forth. In these circumstances slight inhibitions which have started to develop may sometimes be overcome by changing the surroundings as much as possible. The most effective changes may be a change of teaser cow, change of site of collection, change of collector.

It also follows that if inhibitions have been reinforced by familiar surroundings, unfamiliar or distracting surroundings may have a reverse effect. It often happens that a bull which is rather slow at service can be speeded up if his attention is slightly distracted by

such devices as twitching the nose ring, encouraging him by talk, or even by gentle beating or prodding. Another device is to keep the teaser cow moving in front of him.

Each bull has his own individuality and each must be treated in a different way. The man responsible for the collection must therefore be thoroughly experienced and know each bull intimately.

FIG. 25. Bull stocks for holding bull during trimming of feet.

In practice the most important points to remember in handling the bull for collection are as follows:

(1) The greatest care must be taken to hold the artificial vagina at the right angle. It is better to miss a collection, or allow the bull to serve the teaser cow than attempt collection with the vagina held at such an angle that the bull experiences pain on thrusting.

(2) The artificial vagina must have correct lubrication, temperature and pressure.

(3) The bull should be used regularly but not too often.

(4) At the first sign of slowness, weak thrust or poor semen, the bull should be rested.

(5) Every care must be taken to avoid repetition of unsuccessful attempts, especially at short intervals between trials.

(6) Change of teaser cow, change of site of collection, and other devices can be used to circumvent slight inhibitions, but it is better, and easier, to prevent inhibitions from developing than to try to cure them when firmly established.

Another point that needs attention, in old bulls especially, is the feet. Hoofs should be properly trimmed, and for this purpose, where a lot of bulls are kept, bull stocks for holding the bull (see Fig. 25) are a great convenience.

The feet of old, heavy bulls which have to stand for some time on hard concrete are liable to get sore, and exercise on soft ground, such as a grass paddock, is an advantage.

The hair of a bull in the neighbourhood of the penis and sheath should be kept well trimmed so that it does not get in the way at collection and injure the penis or contaminate the semen.

Records. Since the main object of Artificial Insemination is the improvement of livestock, adequate and accurate records should be kept of all operations. Moreover, the records require to be kept in such a way as to present a running picture of the working of the Centre and to form a basis for spotting failures, or requirements, so that immediate action can be taken. While the system described here is one way of doing this, other systems, provided they supply the required information, may be equally good.

As phone calls come in to the Centre they are entered in a *Day Book* (see Fig. 26).

Columns 2 to 6 are filled in by the girl in the office as the calls come in. At a fixed time in the morning, when all the calls should have come in, the Director of the Station will allocate the calls to different lay inseminators, putting their initials in column 1 and showing the order in which they will visit herds, so that, if required for extra calls which have come in late, they can be phoned up during the course of their rounds.

When the inseminator goes out on his rounds he takes with him a book of forms on which he enters up the details concerning the cows inseminated (Fig. 27).

Column: 1	2	3	4	5	6
Initials of Inseminator and order (1, 2, 3, etc.) in which he will visit the herds	Date and time of call	Name of farmer and address of farm at which cow is	Whether cow first seen on heat a.m. or p.m.	Breed of bull required	Name of bull if special bull required
F.W. (1)	*10 July 9 a.m.*	*Smith, Home Farm, Lode*	*p.m.*	*S.*	
J.U. (1)	*10 July 9.10 a.m.*	*Turner, Heath Fm., Barton*	*a.m*	*F.*	*K.H.*
F.W. (2)	*10 July 9.12 a.m.*	*Knibbs, Cross Fm., G'gay*	*a.m.*	*S.*	

FIG. 26. Page from daybook.

Name of Farmer S. J. Morgan.

Address Willow Farm, Fordham.

Date of Insemination 18. 12. 45.

Name of Cow Daisy 1st.

Type ✓ S. F. J. G. A. R P. Grade of Dam

Herd No. 34

Herd Book No.

Milk Recording No. V. 12586

Bull used K. H. Age of Sperm 24hrs Vol. 1cc Dil. 1-7

Stage of Heat Full.

Remarks

CAMBRIDGE AND DISTRICT CATTLE BREEDERS' SOCIETY.

INSEMINATION CERTIFICATE.

Cow Insem. Daisy 1st.

Herd No. 34.

Herd Book No.

Milk Recording No V. 12586

Bull Used Kingswood Homespun 55255.

Signed C. J. Morgan

Date 18. 12. 45.

This cow has not been and will not be served by any bull during this heat period.

Signed

FIG. 27. Leaf from inseminator's book.

On the counterfoil which remains in the book are entered up the following details:—

Name and address of herd owner.
Date of insemination.
Breed of cow—by making a tick (✓) against the appropriate initial.
Name and tattoo number (pedigree or Milk Recording Society) of the cow.
Breed and name of bull used—together with code number of semen samples (see Fig. 29).
State of heat of cow inseminated.

On the portion which is torn off (right side of Fig. 27) the inseminator enters the following particulars:—

Name and number of cow.
Bull used.
Signature of inseminator.
Date.

After completing the form, the right-hand side is signed by the inseminator, torn off, and handed to the owner of the cow. If the cow is a pedigree or "graded-up" animal, the slip, after being counter-signed by the owner (to certify that the cow has not had access to any bull during this heat period) can be used as a "service record" when the calf is being entered in the herdbook. Breed Societies have their own regulations governing the entry of calves produced as a result of artificial insemination, but most Breed Societies now accept such a signed form.

The inseminator uses two such service books, each on alternate days. After completing one day's work he hands the book into the office and next day the entries from this book are transferred to the card index in the office, while he takes out his other book with him on his rounds.

In the Office the records from all the inseminators' books are entered up on *Index Cards* (Fig. 28).

On each card the following particulars are entered:—name and address of owner, name and number of cow, breed and type of cow (denoted by initial—S = Shorthorn) as a heading, with columns for date, age of sperm, volume of semen used, dilution of semen, state of heat of cow, code number of semen sample used, notes (method of insemination—U = uterine), date calved, sex of calf, and tattoo number of calf.

NAME *S. J. Morgan* COW *Daisy 1st* TYPE *S*

ADDRESS *Willow Farm, Fordham* NO. *34* *V. 12586*

Date	Age	Vol.	Dil.	State in Heat	Code	NOTES	Calved	Sex	Calf No.
18.12.45	*24 hrs.*	*1 ml.*	*1-7*	*Full*	*KH 278*	*U*			

FIG. 28.

There is a separate card for each cow inseminated and these are filed under herd owners' names. The card is ruled out in lines so that if the cow turns and has to be re-inseminated this is also entered and when the cow becomes pregnant, as judged either by rectal palpation by the Veterinary Officer, or by her failing to come back for re-insemination over a period of three months, a red line is drawn across the card.

These cards can be continued from one year to another and constitute what amounts to a herd record for animals in the Society.

Calving dates are predicted from the date of the last insemination, and a list of expected calvings in the month is made out at the Centre and handed to the calf marker who visits the farms. From the information he obtains, and that already on the cards, a calf register is formed in which not only the calf's number and owner are entered, but its sire and dam. It is essential for any breeding policy to have some quick method of identifying the sire of any calf born to the Society, and the calf register provides this.

Where calves are marked in accordance with the requirements of the Breed Societies or of National Milk Records (Senior Scheme) the dates of birth and ear mark numbers are entered on the calf register of the Insemination Society. Heifer calves which are not marked in accordance with the above are tatooed with the symbol of the Insemination Society and a serial number which is entered in the register.

In addition to the above-mentioned records which are necessary from the breeder's point of view, other records are also necessary for the proper working of the Artificial Insemination Centre.

HISTON ROSEMARY PRINCE
MAY, 1945

Date	Time	Reaction	Motility	Volume	Dilution	Code
4.5.45	10.15 a.m.	Immediate	F. Wave	6·7 ml.	1–4	RP52
7.5.45	10 a.m.	,,	G. Wave	5·4 ml.	1–7	RP53
13.5.45	10 a.m.	,,	F. Wave	7 ml.	1–7	RP54
18.5.45	5.15 p.m.	2 mins.	G. Wave	5·7 ml.	1–10	RP55

FIG. 29. Log book of collection from bulls.

A *log book of the collections made from bulls* is required in order to keep a check on their performance (see Fig. 29) and to detect at the earliest possible moment any falling off in the quantity or quality of the semen.

Each sample collected from a bull is given a serial number, so that the results of that particular sample can be followed up in the entries in the inseminators' books (Fig. 27) and cow cards (Fig. 28).

The inseminations from each bull each day are entered on another form (Fig. 30); first inseminations are shown by 1, and subsequent inseminations of a cow are denoted by 2 or 3 as the case may be.

Date	Kingswood Homespun	Histon Dairy King
July 1st	11112223	11111123
July 2nd	1111123	1111133
July 3rd	etc.	etc.
July 4th		
July 5th		
July 6th		
July 7th		
July 8th		
July 9th		
July 10th ...		
Total number of first inseminations	200	150
Number pregnant	130	105
% Fertility ...	65	70

FIG. 30. Bull insemination record.

If any cows return to service from these inseminations at the end of three weeks a red mark is put through the black number. Three months later the results for each month are finalised with the total

number of inseminations, the number of these which have not returned within that time, and the percentage of fertility for each bull. Three months' interval is allowed as a reasonable time for the return to service if the cow is not pregnant. This is an arbitrary time, but it is a convenient one, although it shows results slightly above (about 3%) the actual fertility percentage as determined by calvings.

A similar table is kept for inseminations made by the different inseminators working at the Centre, the inseminators' initials being substituted for that of the names of the bulls (see Fig. 30). This enables a check to be kept on the efficiency of the inseminators, so that if the results obtained by any inseminator are below the general level for each bull his technique can be improved with the least possible delay.

Training. Some suggestions on methods for the training of inseminators are given, since a proper training for those who are operating Centres plays such a considerable part in the success of the whole venture.

Training in the collection of semen with the artificial vagina should not be done on the valuable bulls being used by the Society, in case inexperience by the trainee should damage or "put off" the bull for service. At first the trainee should get practice on cheap bulls, such as those which are going for slaughter. When he has shown himself efficient at this and is starting to collect at a Centre he should be allowed to collect first from a young bull which is being used on a limited number of cows, or on a reserve bull, and only allowed to collect from the old, valuable, proven bulls when he has shown himself to be efficient over a period of time. If these precautions are taken the valuable, old, proven bulls will be given a better chance of a long period of active service.

For training in the act of inseminating a cow it would be quite unfair for a trainee to practice on members' cows, as they require to get them in-calf at the earliest opportunity and do not want to take any risk or injury to their cows. The best place at which to begin training is at the slaughter house on cows which are just about to be slaughtered Here, for the purpose of inseminating, a gentian violet ink (such as is used for stamping carcases) is used in place of semen. This has the advantage that after the cow has been killed, opened up, and the genital organs exposed, the exact spot in which the ink has been deposited by the inseminator can be seen by the trainee and the in-

structor; and so, if it has not been deposited in the right place the trainee can be told exactly what he has done wrong. The instructor should also be able to check easily the amount of fluid left in the inseminating tube. After obtaining proficiency at a slaughter house the trainee may be allowed to inseminate cows belonging to members of the Centre, but it is preferable that he should not at first operate in valuable pedigree or grading-up herds. If conditions make it possible it is also preferable for a new inseminator to take up his duties at an Artificial Insemination Centre during summer or early months of autumn when the necessity for getting cows in-calf quickly is not so urgent as it is during the winter and early spring months. If he begins work at a Centre during the slack time of the year he will have a chance of getting into the routine before the heavy pressure of work begins in the winter months. He must be approved by the Ministry before he may inseminate a farmer's cows.

In addition to instruction in the apparatus used in the actual manual operations of collection, handling of semen and insemination, the inseminator should be given some knowledge of the anatomy and physiology of the reproductive organs of the cow and bull (see Bulletin 39, Ministry of Agriculture and Fisheries) and something of the common genital diseases in cattle as well as methods of sterilisation of apparatus and the use of antiseptics. If he is to take a real interest in his work he should also know something about Cattle Breeding and Improvement (see Pamphlet No. 12, Bath and West and Southern Counties Society) as well as methods of feeding and management of bulls. He should have a knowledge of the breeds of cattle and methods of grading-up and registration in operation by the different Breed Societies as well as details of the Milk Recording and Livestock Improvement Schemes. It will also be necessary for him to know the details of the Diseases of Animals Acts and Orders as they apply to cattle.

For those who may wish to obtain further details concerning artificial insemination in cattle and other species of livestock the following book is recommended:—

The Artificial Insemination of Farm Animals, by E. J. Perry, J. W. Bartlett, G. E. Taylor, J. Edwards, C. E. Terrill, V. Berliner and F. P. Jeffrey. Publishers: Rutgers University Press, New Brunswick, New Jersey, U.S.A., 1945.

APPENDIX

NOTES ON PREGNANCY DIAGNOSIS IN CATTLE

Pregnancy can be diagnosed with accuracy from 56 days (8 weeks) onwards.

Technique of Diagnosis per Rectum.

The gravid uterine horn can usually be recognised by the following signs :—

56TH DAY:—

(1) Increase in size compared with the non-pregnant horn.

(2) The increase takes the form of a "bulging" of the horn. (Shape of the bulge is similar to that of the testicle of a bull.)

(3) It feels full of fluctuating fluid through a thin wall.

(4) The pregnant horn has a tense or resilient feeling. (This is more easily recognised by experience than described.)

(5) Recognition of the double wall of the uterine horn. (This consists of the wall of the uterus and the placenta.)

(6) The presence of a well-developed corpus luteum in the ovary corresponding to the gravid horn.

56TH-120TH DAY:—

The pregnant horn can be felt increasing in size and eventually beginning to drop into the abdomen. The fœtus may be felt "bouncing" against the palm of the hand at this stage.

120TH-180TH DAY:—

The developing uterus has fallen into abdominal cavity and diagnosis is a little more difficult. Diagnosis can be made by identifying the cervix, and following the uterus back over the brim of the pelvis where it is felt as a broad, flat band. Between 120 to 150 days (4 to 5 months) the cotyledons may be felt "bobbing" against the palm of the hand like floating corks.

180TH-285TH DAY:—

The cotyledons and fœtus are easily recognised, and by the 240th day (8 months) the limbs of the fœtus can be identified. Duration of pregnancy at this stage is diagnosed by the approximate size of the limbs of the fœtus.

Additional Aids to Diagnosis.

(1) Dry, sticking feeling of vagina.

(2) Cervical seal—may vary from a pin point to a large splash over external cervix. Present usually from 35 days (5 weeks) but is *not* always visible.

(3) Enlargement and characteristic pulsation of the middle uterine artery on the same side as the pregnant horn. This can be felt per rectum from the 120th day (4th month) onwards and compared with the non-pregnant side.

Twin Pregnancies.

Twins developing one in each horn, although uncommon, may cause difficulty, owing to the inability to compare the relative sizes of the horns. The presence of two *corpora lutea* in one ovary, or one in each ovary, is the only aid in the early stages. Enlargement of the uterine arteries on *both* sides occurs, if there are twins with one fœtus in each horn.

Warnings.

(1) Cessation of œstrus *does not* necessarily indicate pregnancy.

(2) Continuation of œstrus *does not* always indicate non-pregnancy.

(3) *Absence* of *corpus luteum* means absence of pregnancy.

(4) The following may be confused with the enlarged pregnant uterus:—

(*a*) *Endometritis.* Recognised by the enlarged cervix, absence of double wall and loss of tone (i.e. "Doughy" feeling).

(*b*) *Pyometra.* When uterus is in abdomen, this may be diagnosed by absence of developing cotyledons and uterine arteries, accompanied by cervicitis.

(*c*) *Mummified fœtus.* Identification similar to (*b*).

(*d*) "*White Heifer Disease.*" May be distinguished by failure to identify the cervix and the absence of double wall.